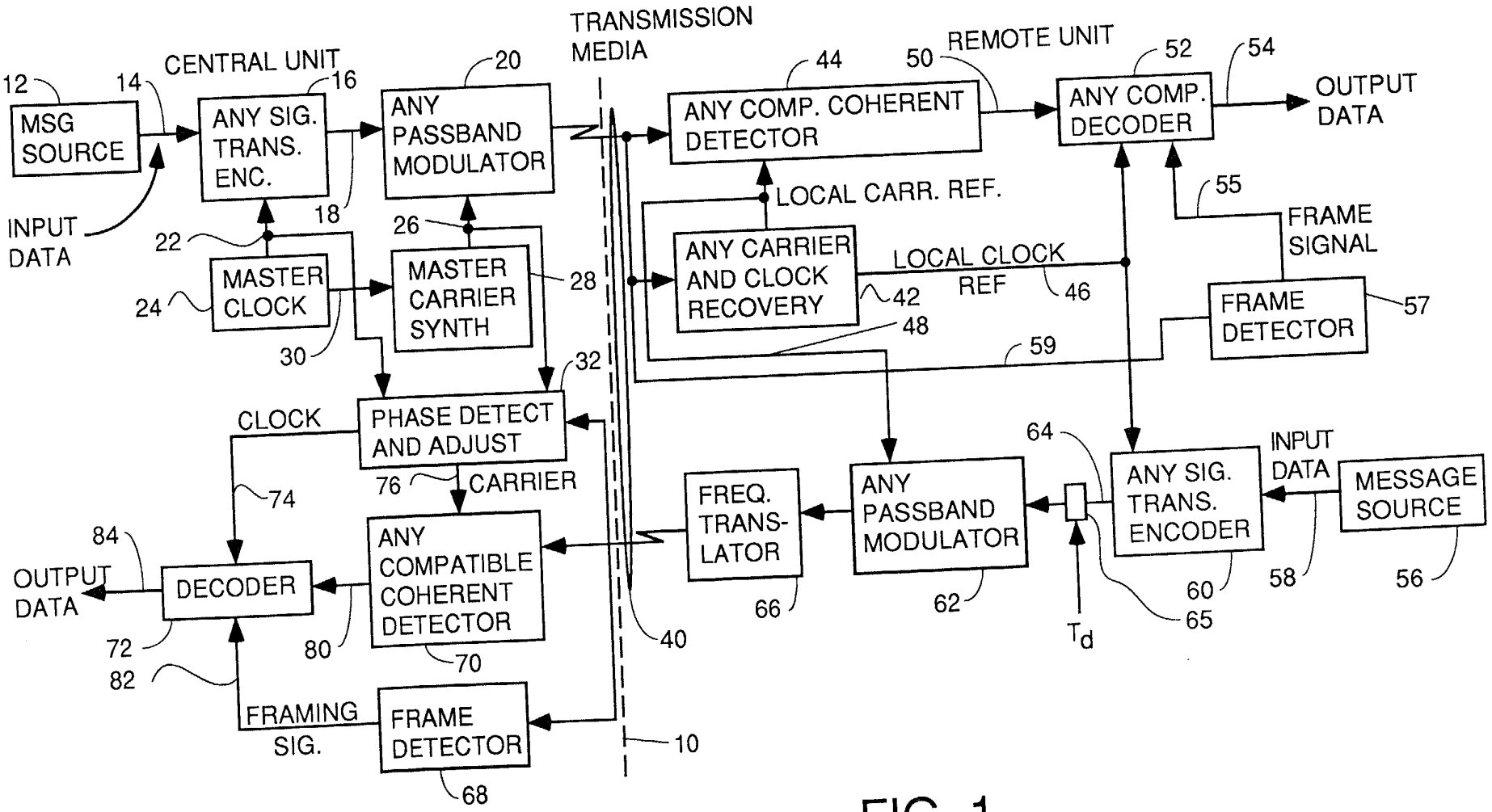


FIG. 1

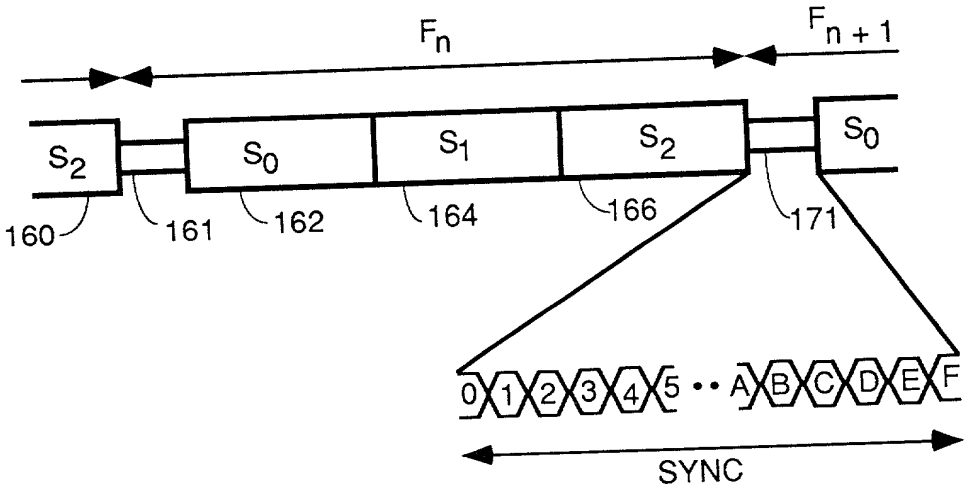

F_n
F_{n+1}
S_2
S_0
S_1
S_2
S_0
160
161
162
164
166
171
0 1 2 3 4 5 • • A B C D E F
SYNC

FIG. 2A

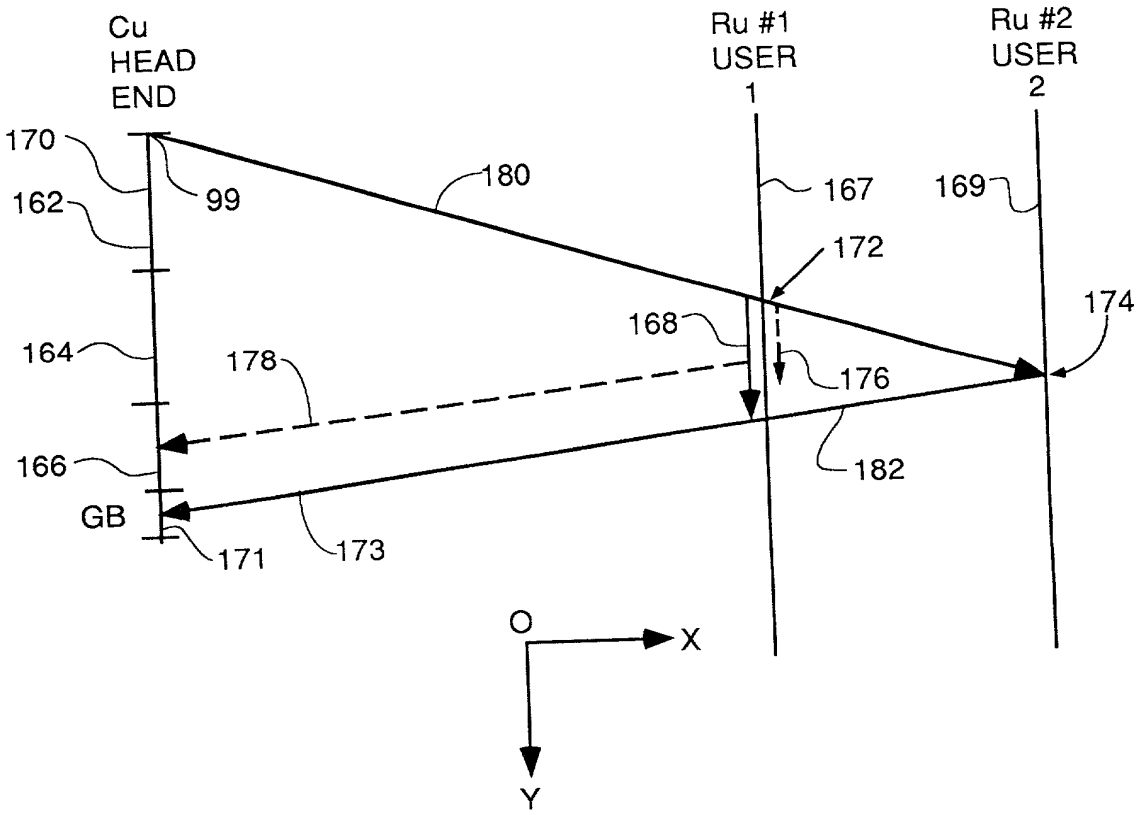

Cu
HEAD
END
Ru #1
USER
1
Ru #2
USER
2
170
99
180
167
169
162
172
174
168
164
178
176
166
182
GB
171
173
O
X
Y

FIG. 2B

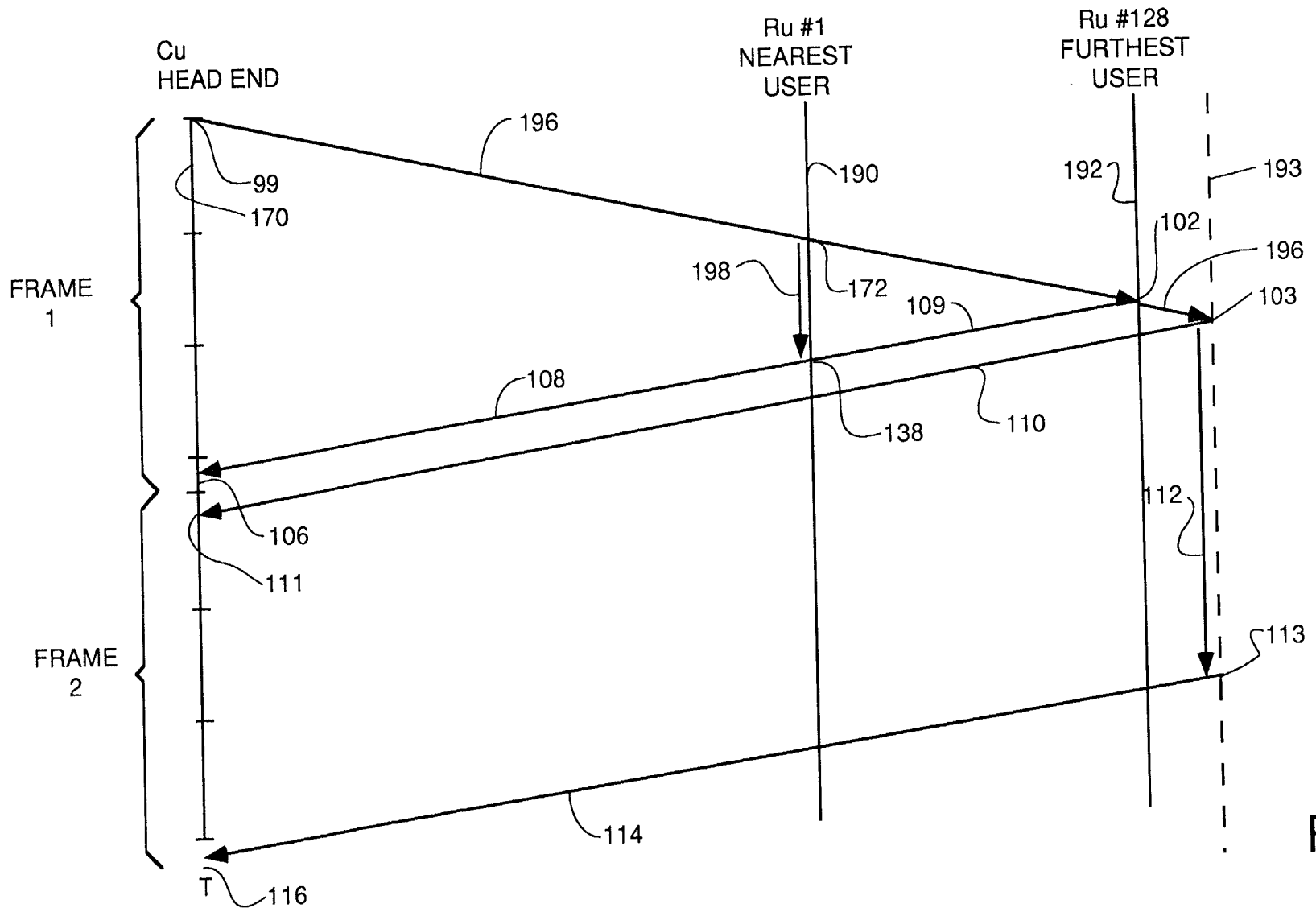

Cu
HEAD END
Ru #1
NEAREST
USER
Ru #128
FURTHEST
USER
196
99
170
190
192
193
102
196
198
172
109
103
108
138
110
112
106
111
113
FRAME
1
FRAME
2
114
T
116

FIG. 3

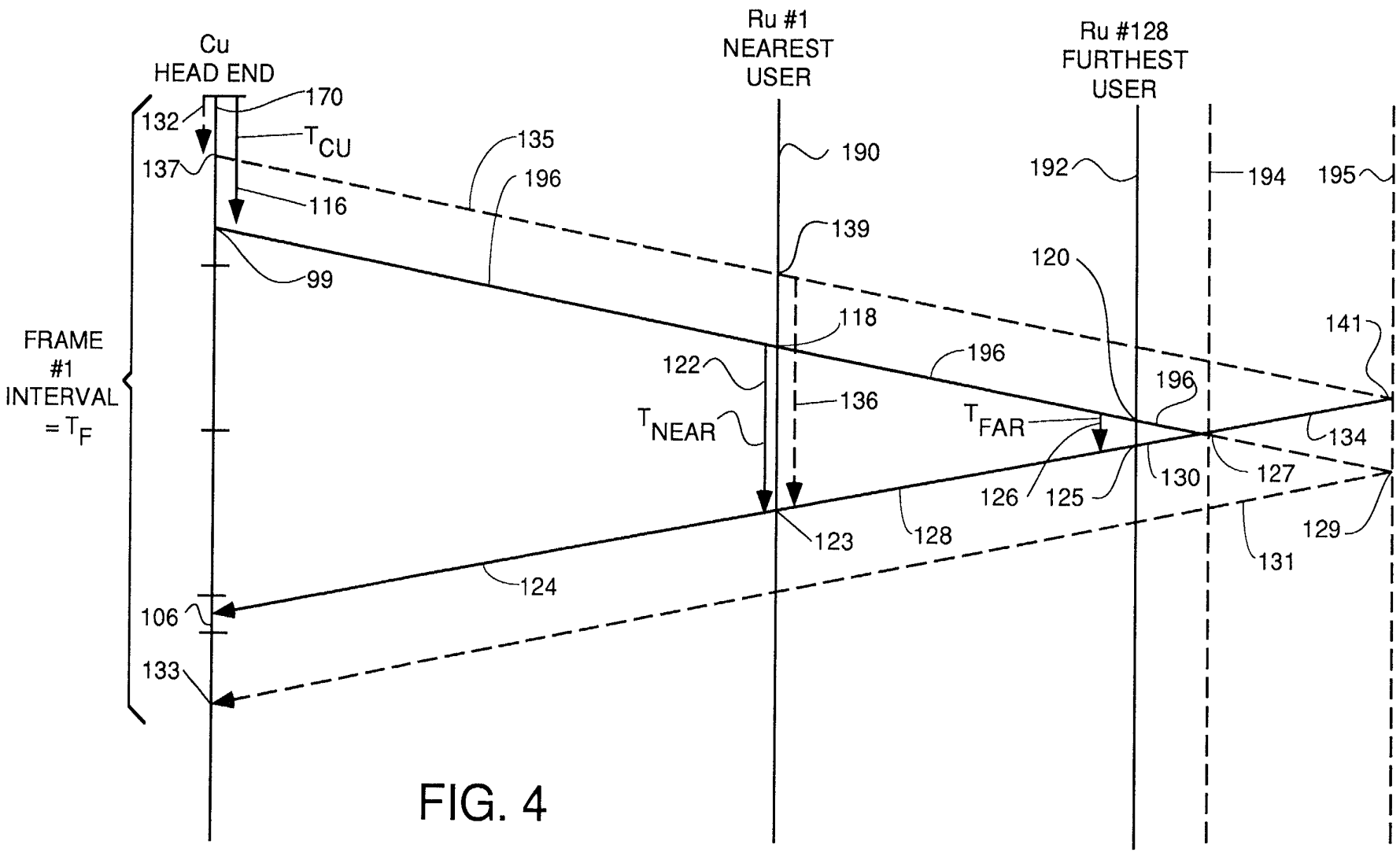
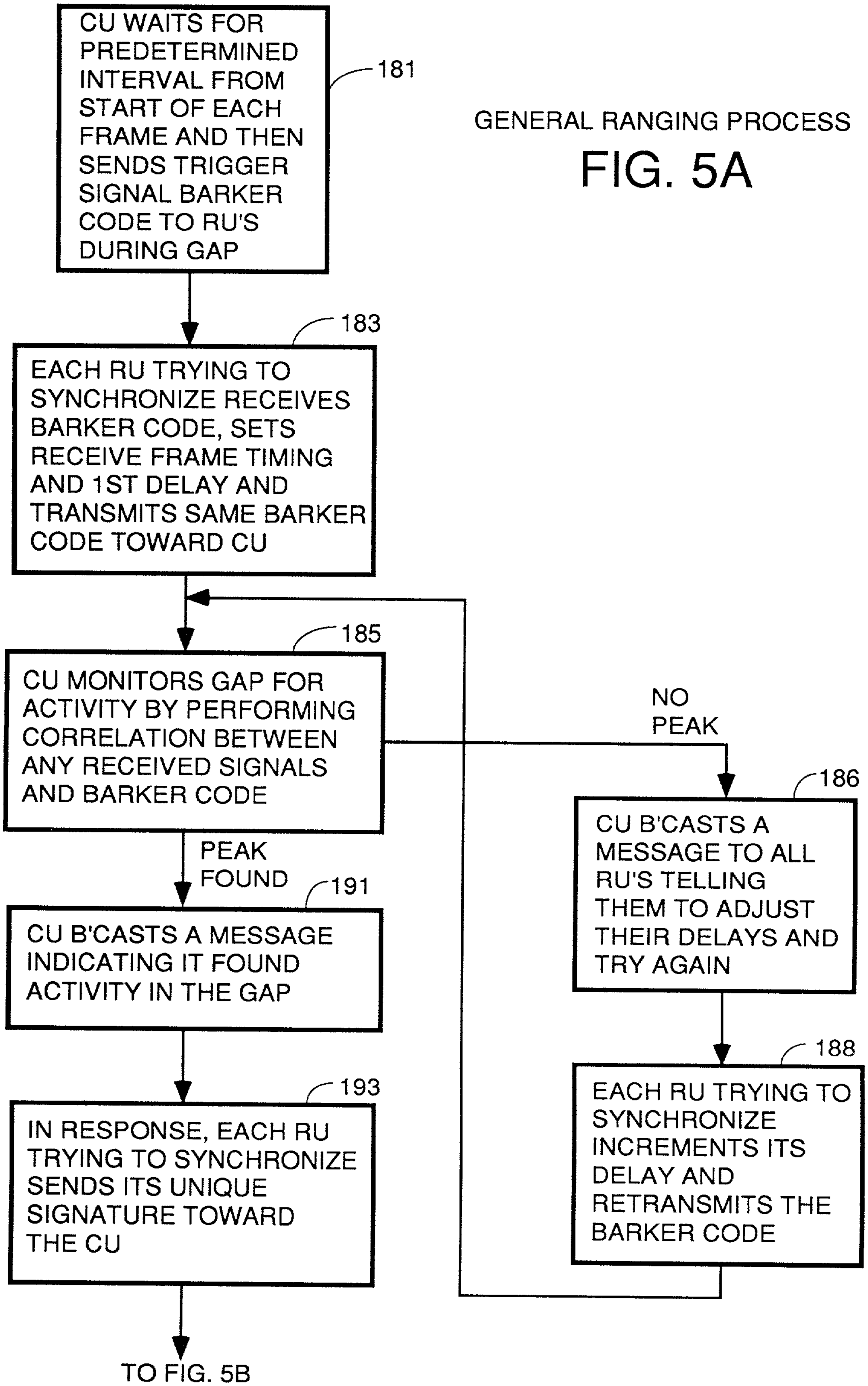


FIG. 4


CU WAITS FOR PREDETERMINED INTERVAL FROM START OF EACH FRAME AND THEN SENDS TRIGGER SIGNAL BARKER CODE TO RU'S DURING GAP
181
183
EACH RU TRYING TO SYNCHRONIZE RECEIVES BARKER CODE, SETS RECEIVE FRAME TIMING AND 1ST DELAY AND TRANSMITS SAME BARKER CODE TOWARD CU
185
CU MONITORS GAP FOR ACTIVITY BY PERFORMING CORRELATION BETWEEN ANY RECEIVED SIGNALS AND BARKER CODE
NO PEAK
186
CU B'CASTS A MESSAGE TO ALL RU'S TELLING THEM TO ADJUST THEIR DELAYS AND TRY AGAIN
188
EACH RU TRYING TO SYNCHRONIZE INCREMENTS ITS DELAY AND RETRANSMITS THE BARKER CODE
PEAK FOUND
191
CU B'CASTS A MESSAGE INDICATING IT FOUND ACTIVITY IN THE GAP
193
IN RESPONSE, EACH RU TRYING TO SYNCHRONIZE SENDS ITS UNIQUE SIGNATURE TOWARD THE CU
TO FIG. 5B

GENERAL RANGING PROCESS

FIG. 5A

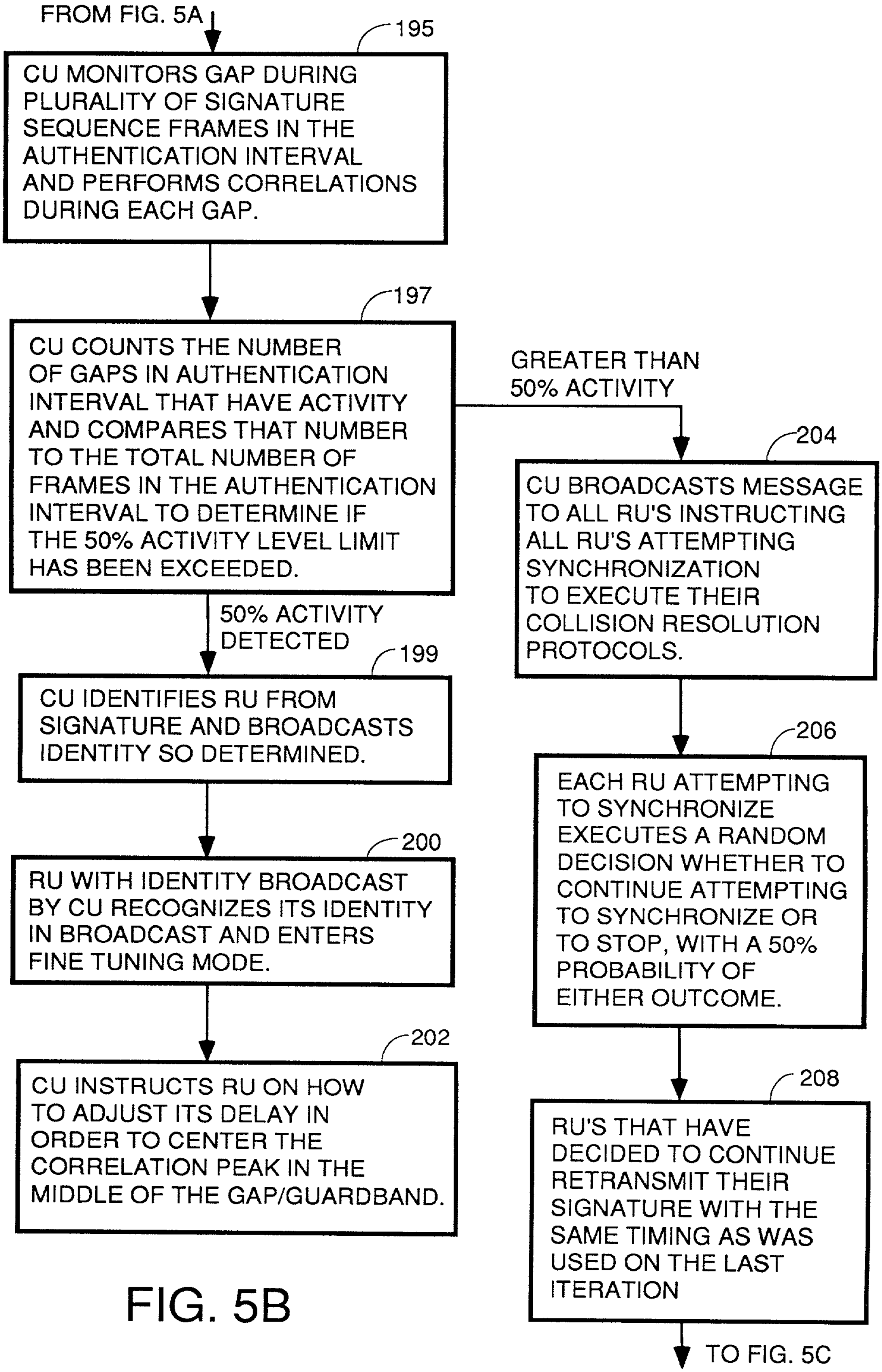

FROM FIG. 5A
195
CU MONITORS GAP DURING PLURALITY OF SIGNATURE SEQUENCE FRAMES IN THE AUTHENTICATION INTERVAL AND PERFORMS CORRELATIONS DURING EACH GAP.
197
CU COUNTS THE NUMBER OF GAPS IN AUTHENTICATION INTERVAL THAT HAVE ACTIVITY AND COMPARES THAT NUMBER TO THE TOTAL NUMBER OF FRAMES IN THE AUTHENTICATION INTERVAL TO DETERMINE IF THE 50% ACTIVITY LEVEL LIMIT HAS BEEN EXCEEDED.
GREATER THAN 50% ACTIVITY
50% ACTIVITY DETECTED
199
CU IDENTIFIES RU FROM SIGNATURE AND BROADCASTS IDENTITY SO DETERMINED.
200
RU WITH IDENTITY BROADCAST BY CU RECOGNIZES ITS IDENTITY IN BROADCAST AND ENTERS FINE TUNING MODE.
202
CU INSTRUCTS RU ON HOW TO ADJUST ITS DELAY IN ORDER TO CENTER THE CORRELATION PEAK IN THE MIDDLE OF THE GAP/GUARDBAND.
204
CU BROADCASTS MESSAGE TO ALL RU'S INSTRUCTING ALL RU'S ATTEMPTING SYNCHRONIZATION TO EXECUTE THEIR COLLISION RESOLUTION PROTOCOLS.
206
EACH RU ATTEMPTING TO SYNCHRONIZE EXECUTES A RANDOM DECISION WHETHER TO CONTINUE ATTEMPTING TO SYNCHRONIZE OR TO STOP, WITH A 50% PROBABILITY OF EITHER OUTCOME.
208
RU'S THAT HAVE DECIDED TO CONTINUE RETRANSMIT THEIR SIGNATURE WITH THE SAME TIMING AS WAS USED ON THE LAST ITERATION
TO FIG. 5C

FIG. 5B

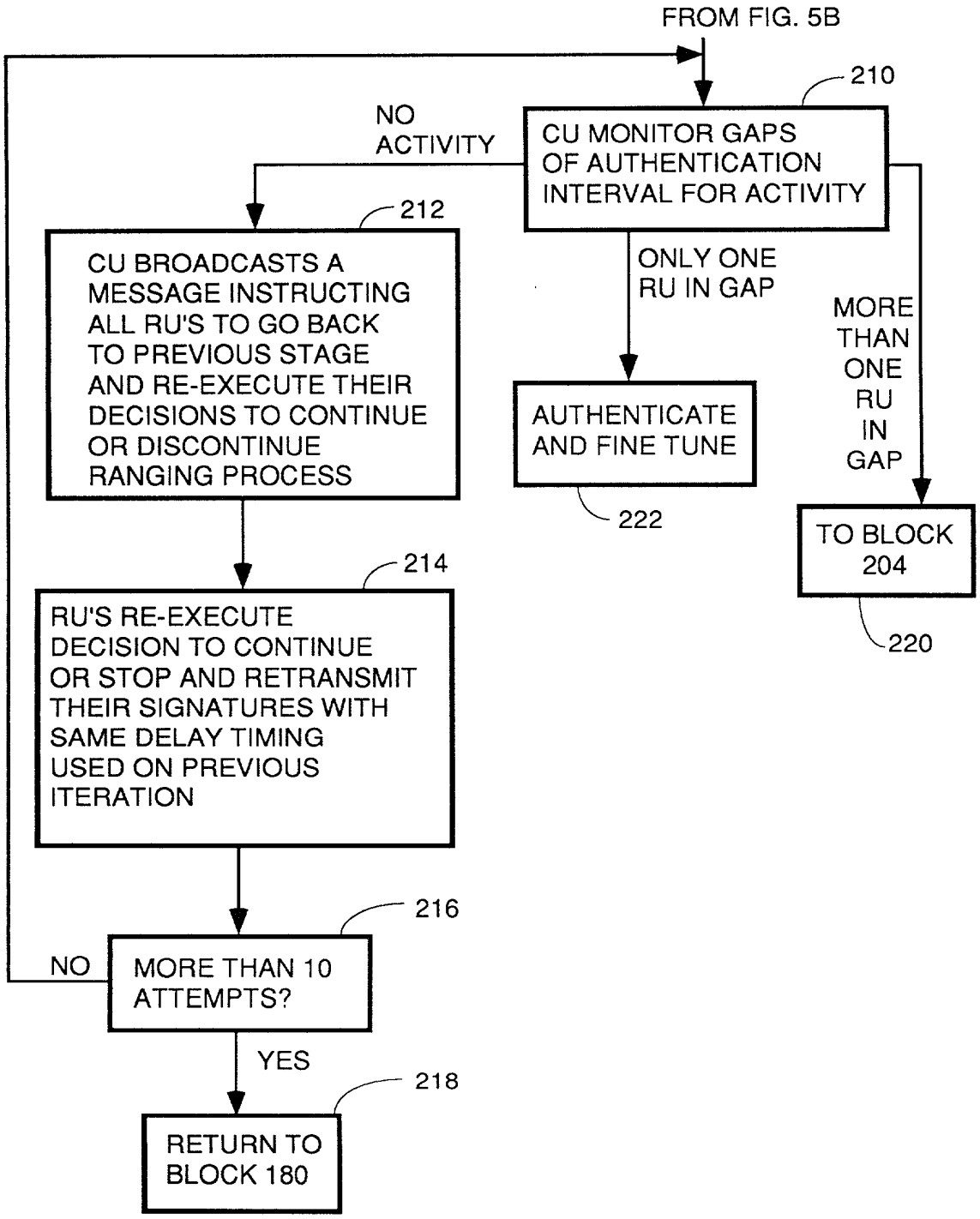

FROM FIG. 5B
210
CU MONITOR GAPS OF AUTHENTICATION INTERVAL FOR ACTIVITY
NO ACTIVITY
212
CU BROADCASTS A MESSAGE INSTRUCTING ALL RU'S TO GO BACK TO PREVIOUS STAGE AND RE-EXECUTE THEIR DECISIONS TO CONTINUE OR DISCONTINUE RANGING PROCESS
ONLY ONE RU IN GAP
AUTHENTICATE AND FINE TUNE
222
MORE THAN ONE RU IN GAP
TO BLOCK 204
220
214
RU'S RE-EXECUTE DECISION TO CONTINUE OR STOP AND RETRANSMIT THEIR SIGNATURES WITH SAME DELAY TIMING USED ON PREVIOUS ITERATION
216
NO
MORE THAN 10 ATTEMPTS?
YES
218
RETURN TO BLOCK 180

FIG. 5C

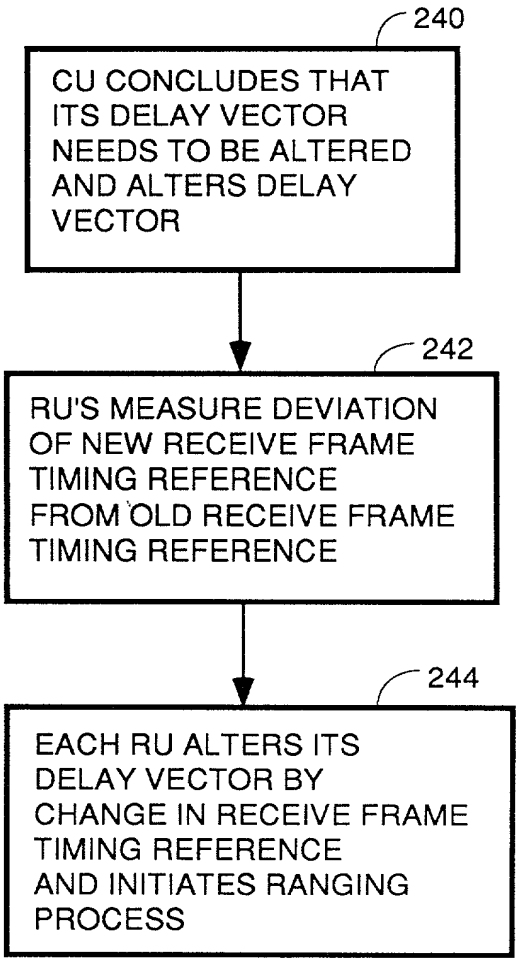


FIG. 6
DEAD RECKONING RE-SYNC

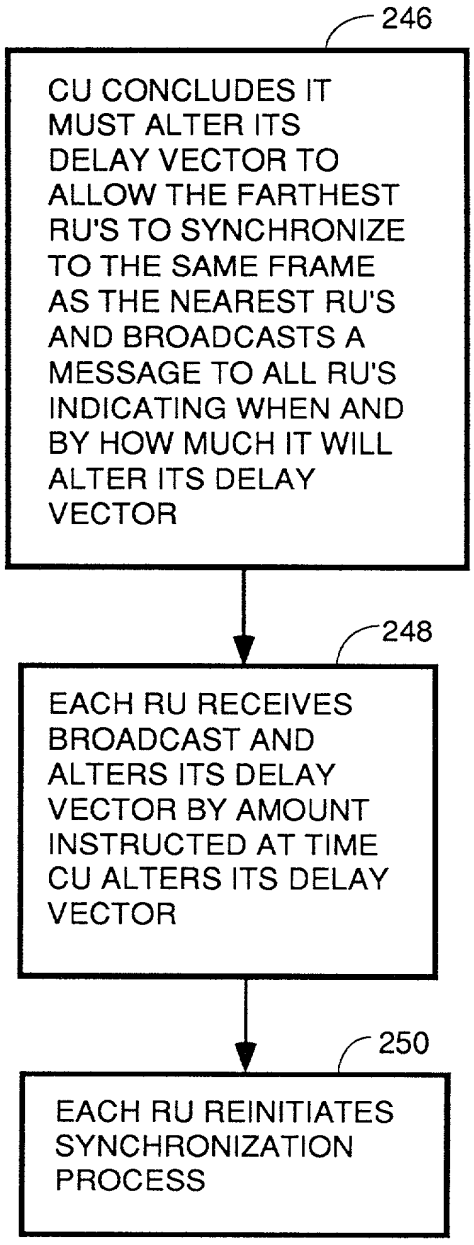
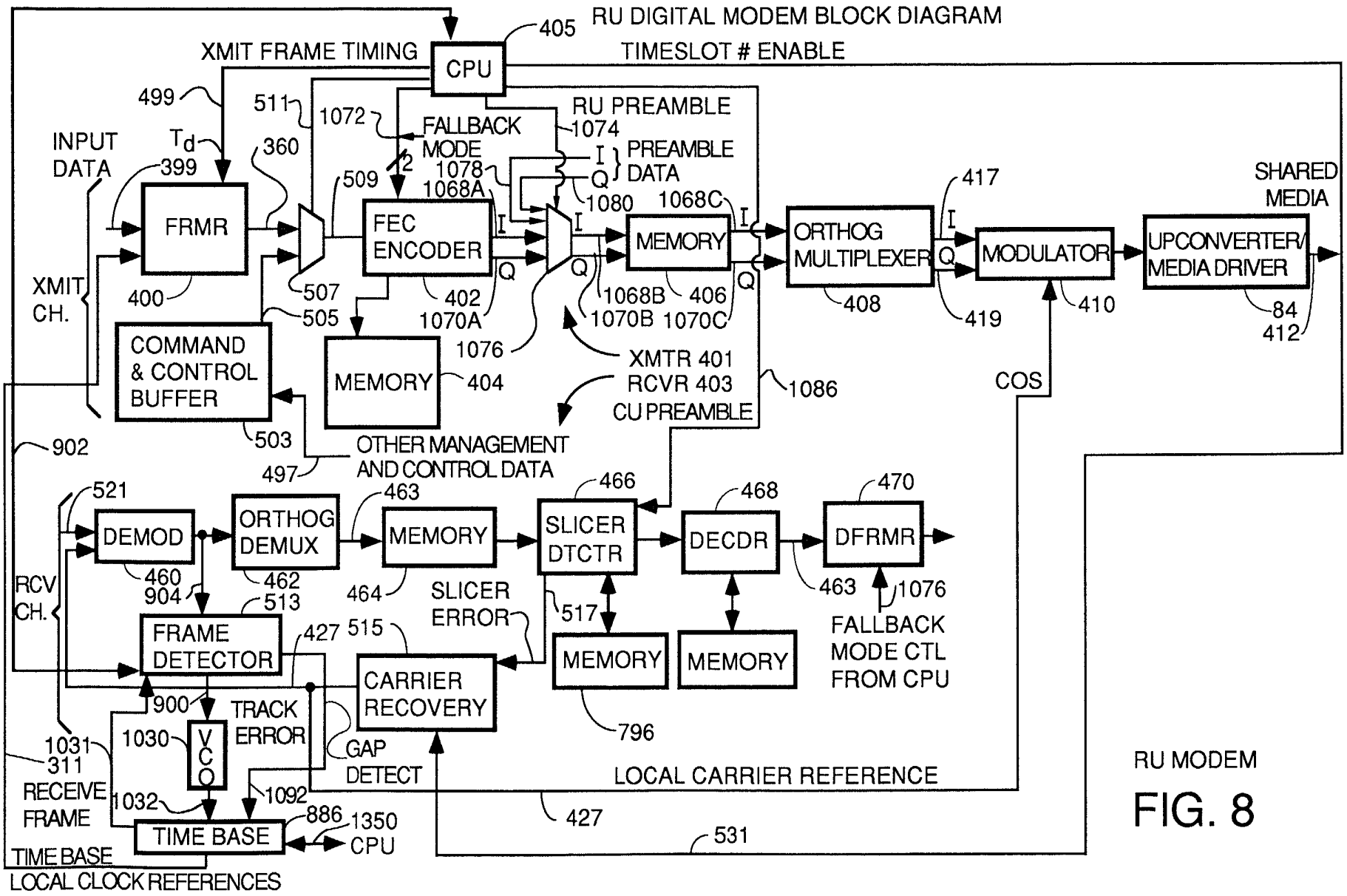


FIG. 7
PRECURSOR EMBODIMENT



RU MODEM

FIG. 8

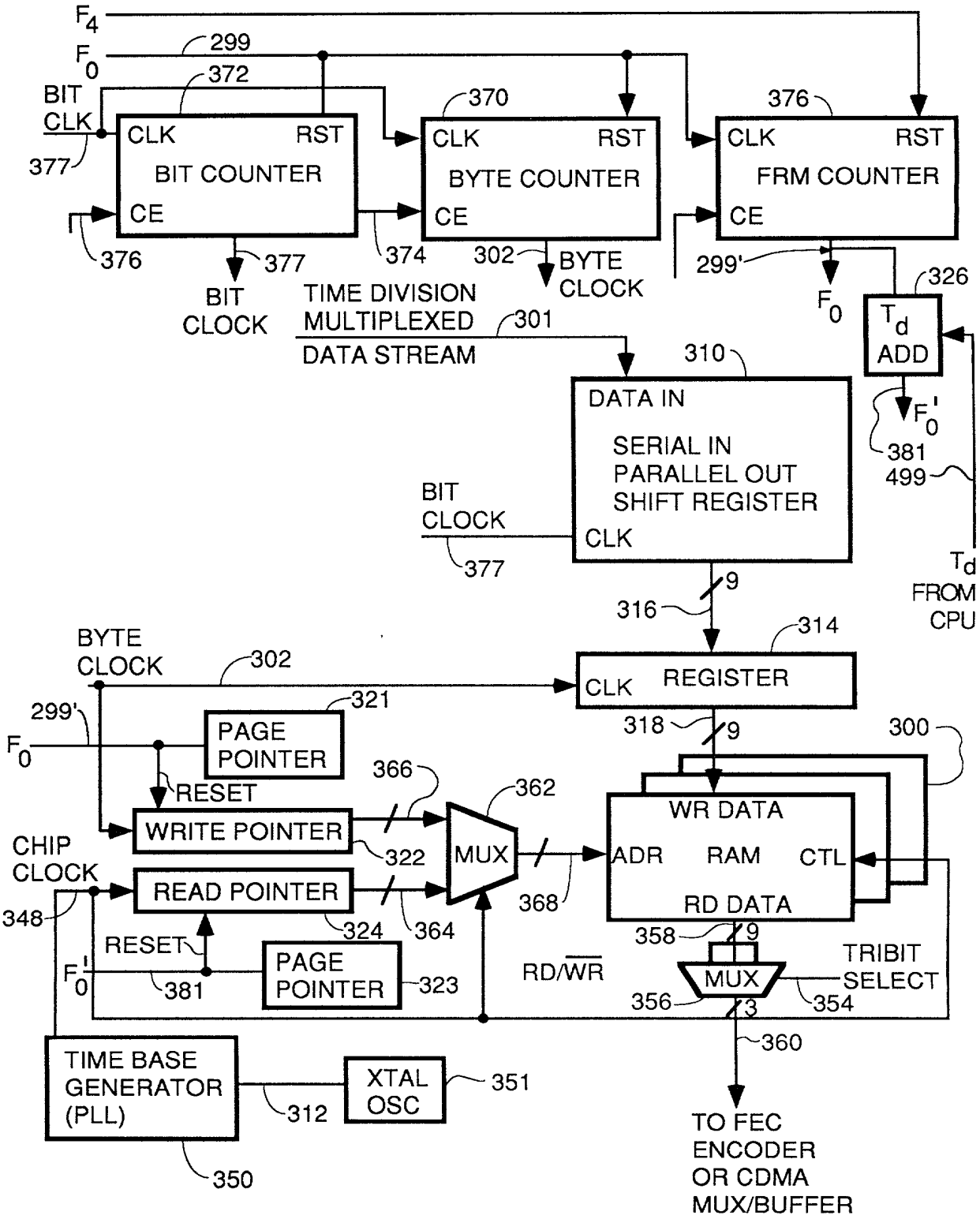

F4
F0
299
372
BIT CLK
377
CLK
RST
BIT COUNTER
CE
376
377
BIT CLOCK
374
370
CLK
RST
BYTE COUNTER
CE
302
BYTE CLOCK
376
CLK
RST
FRM COUNTER
CE
299'
F0
326
Td ADD
F0'
381
499
TIME DIVISION MULTIPLEXED DATA STREAM
301
310
DATA IN
SERIAL IN PARALLEL OUT SHIFT REGISTER
CLK
BIT CLOCK
377
Td FROM CPU
9
316
314
BYTE CLOCK
302
CLK
REGISTER
299'
F0
321
PAGE POINTER
RESET
318
9
300
366
362
WRITE POINTER
322
MUX
WR DATA
ADR
RAM
CTL
RD DATA
CHIP CLOCK
READ POINTER
348
324
364
368
358
9
RESET
F0'
381
PAGE POINTER
323
RD/WR
MUX
TRIBIT SELECT
356
3
354
360
TIME BASE GENERATOR (PLL)
312
XTAL OSC
351
350
TO FEC ENCODER OR CDMA MUX/BUFFER

FIG. 9

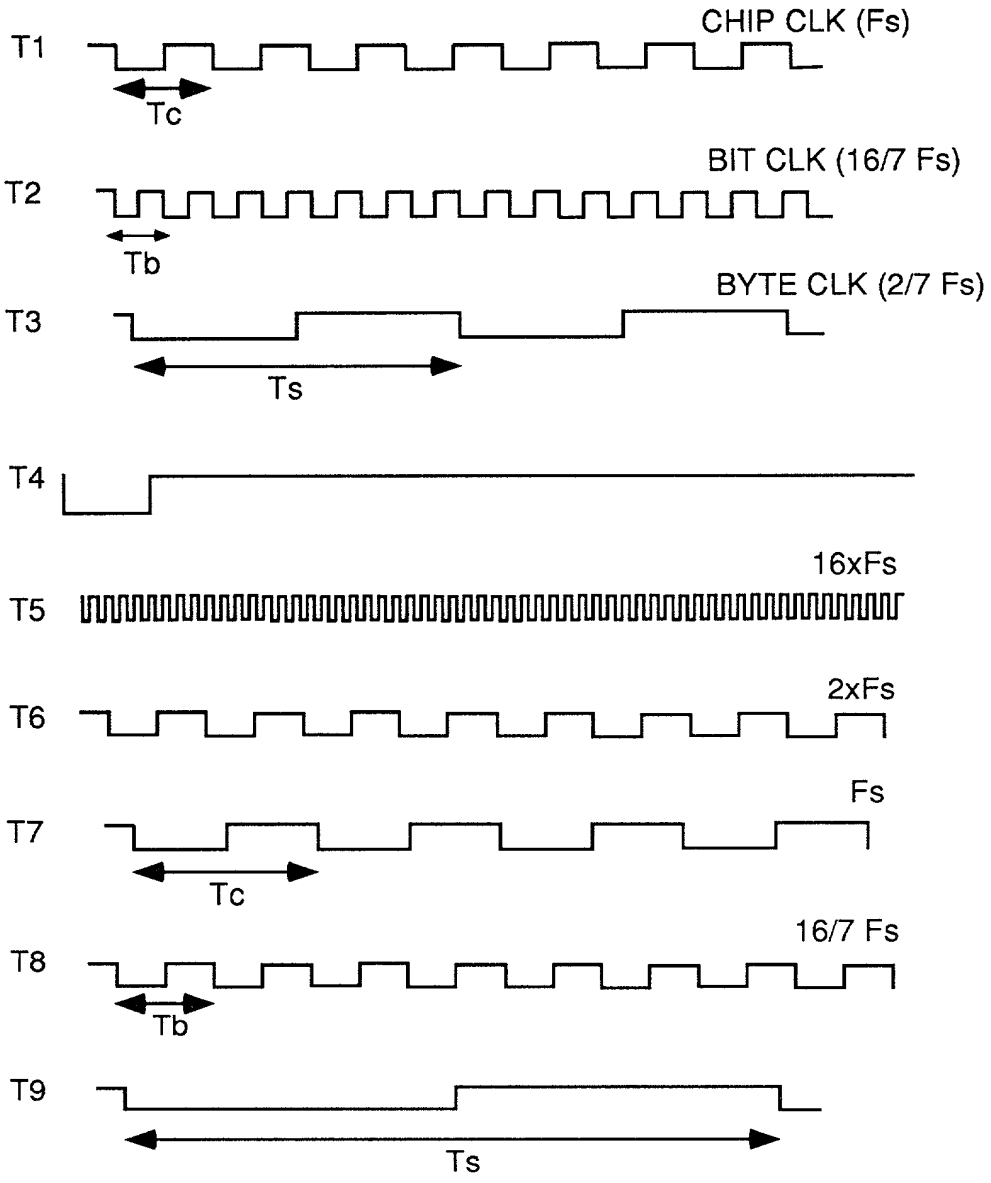

CHIP CLK (Fs)
T1
Tc
BIT CLK (16/7 Fs)
T2
Tb
BYTE CLK (2/7 Fs)
T3
Ts
T4
16xFs
T5
2xFs
T6
Fs
T7
Tc
16/7 Fs
T8
Tb
T9
Ts

FIG. 10

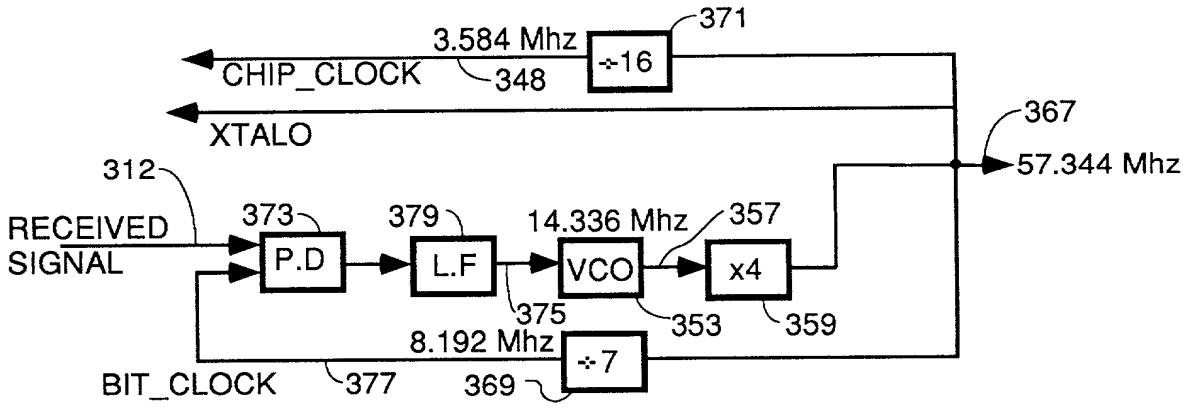


FIG. 11

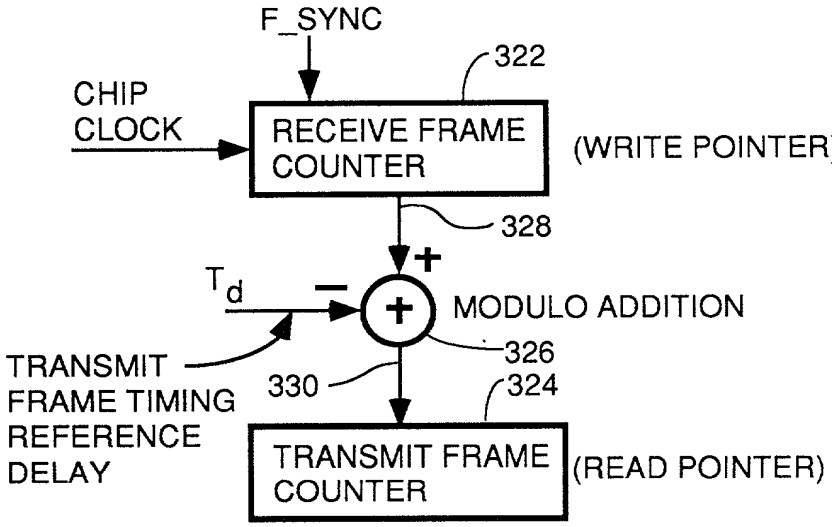


FIG. 12

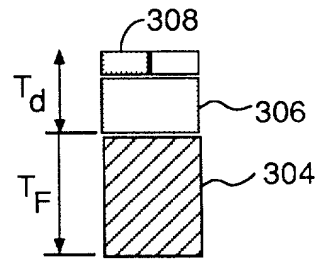


FIG. 13

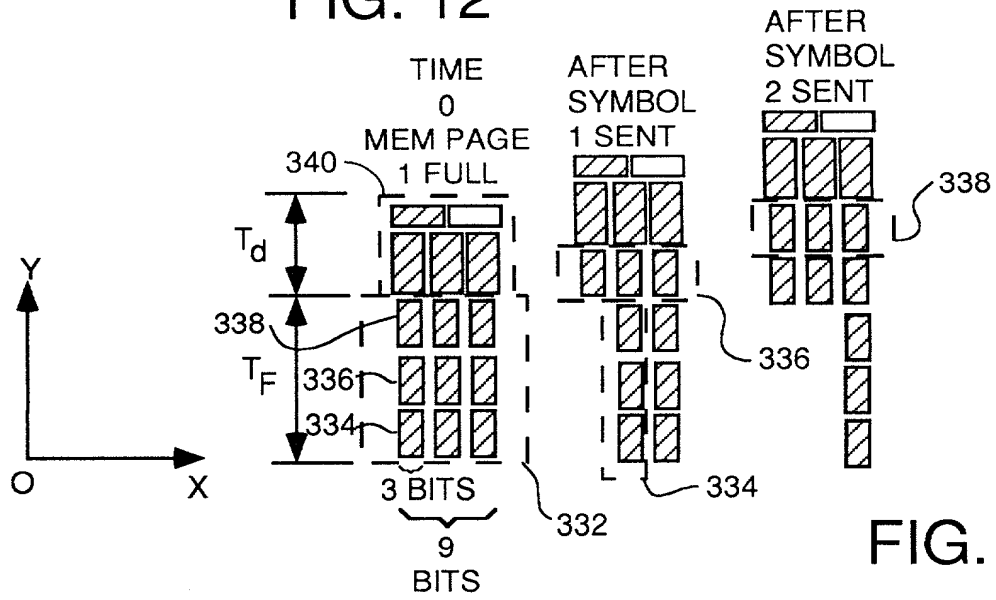


FIG. 14

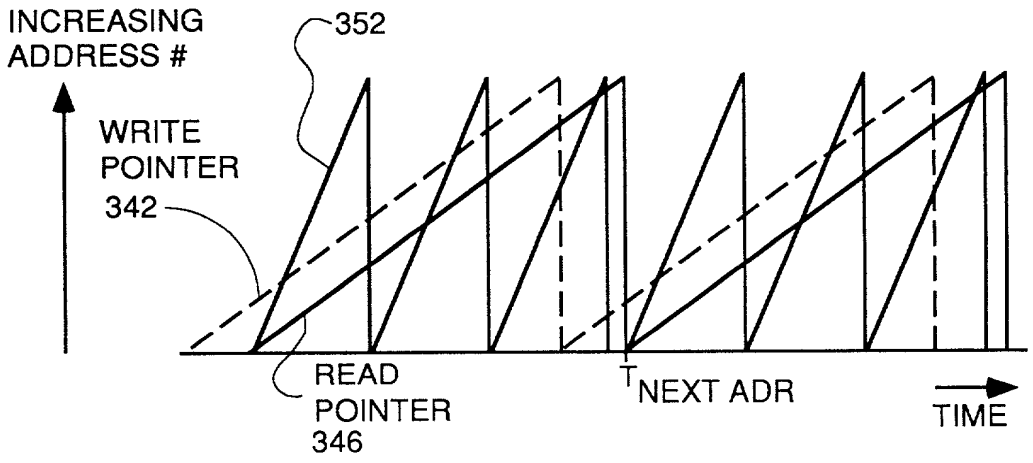

INCREASING
ADDRESS #
352
WRITE
POINTER
342
READ
POINTER
346
T NEXT ADR
TIME

FIG. 15

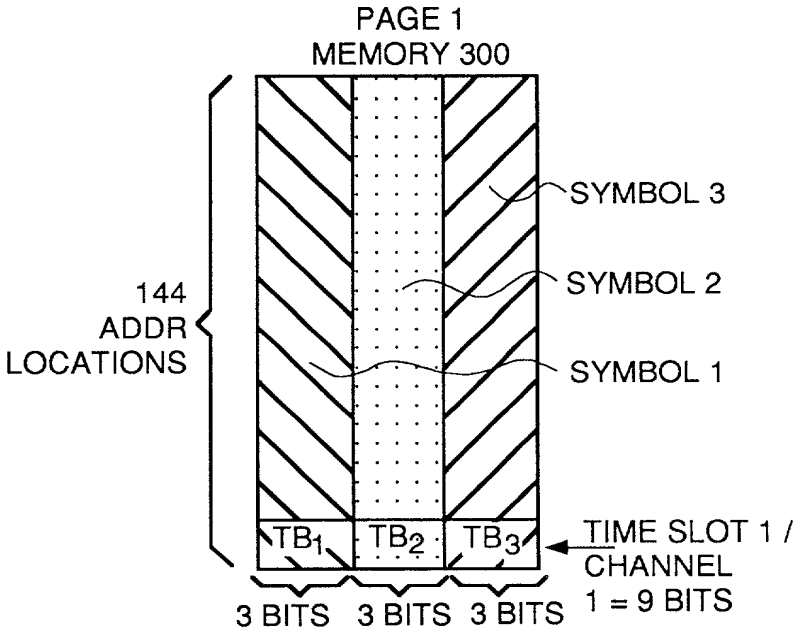
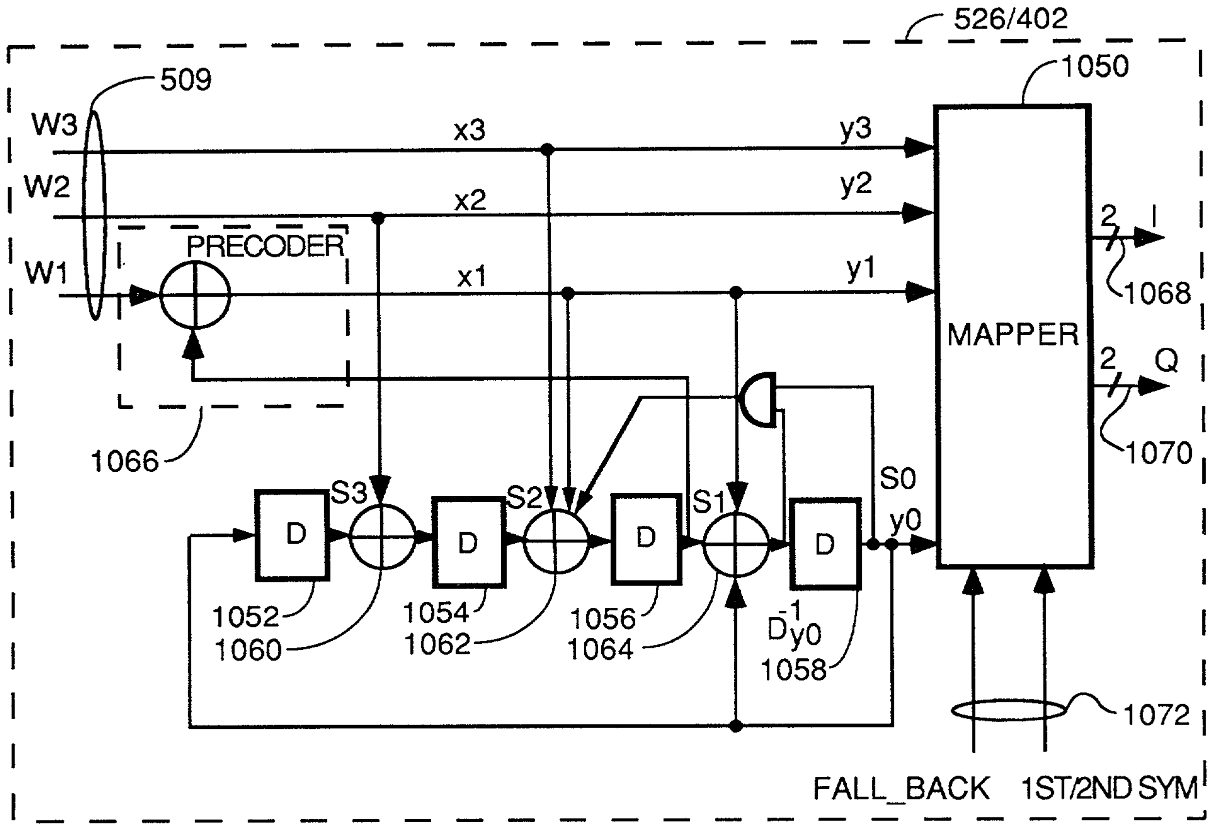

PAGE 1
MEMORY 300
144
ADDR
LOCATIONS
SYMBOL 3
SYMBOL 2
SYMBOL 1
TB1
TB2
TB3
TIME SLOT 1 /
CHANNEL
1 = 9 BITS
3 BITS 3 BITS 3 BITS

FIG. 16



PREFERRED TRELLIS ENCODER

FIG. 17

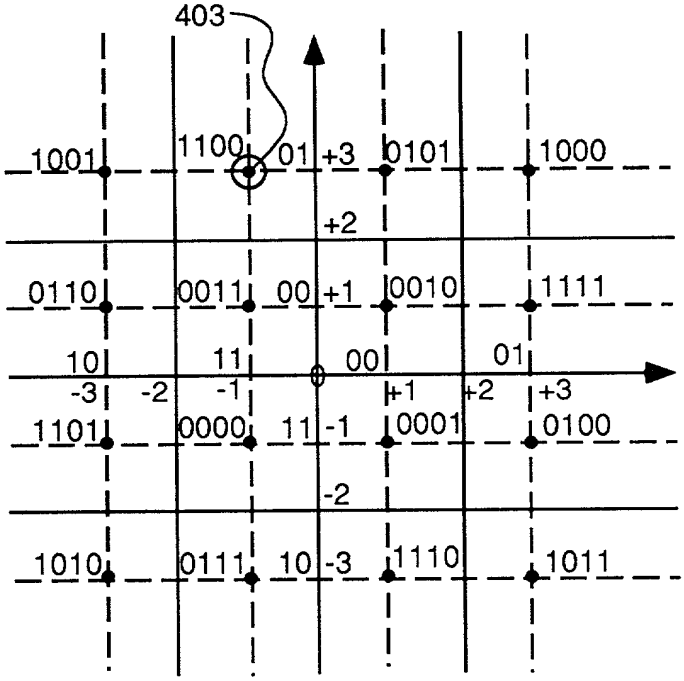


FIG. 18

	0000	111	111	
	0001	001	111	= 1 - j
	0010	001	001	= 1+ j
	0011	111	001	= -1+ j
	0100	011	111	= 3 - j
	0101	001	011	= 1+ 3* j
	0110	101	001	= -3 + j
	0111	111	101	= -1 - 3* j
	1000	011	011	=+3 + 3*j
	1001	101	011	= -3 + 3*j
	1010	101	101	= -3 - 3* j
	1011	011	101	= 3 - 3* j
403	1100	111	011	= -1+ 3* j
	1101	101	111	= -3 - j
	1110	001	101	= 1 - 3* j
	1111	011	001	= 3 + j

FIG. 19

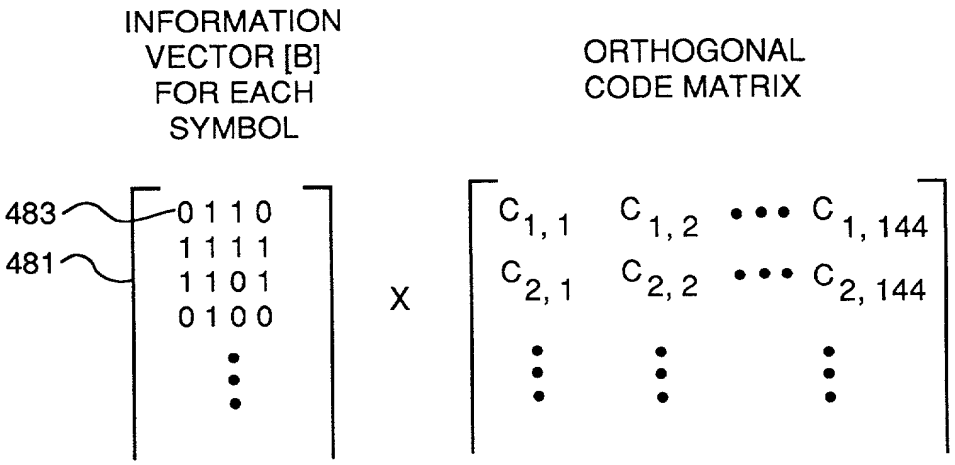


FIG. 20A

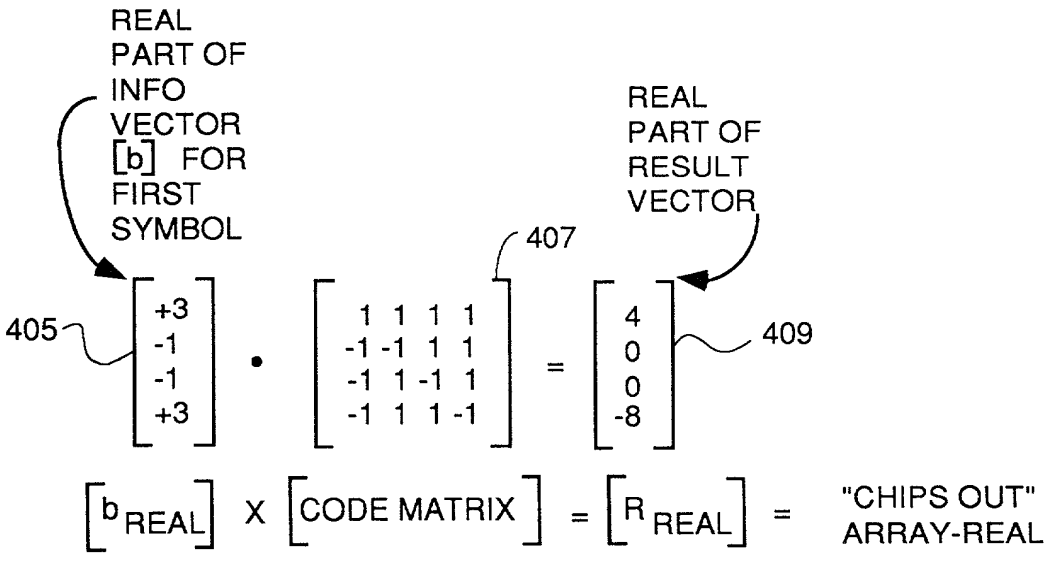


FIG. 20B

MAPPING FOR FALL-BACK MODE - LSB'S

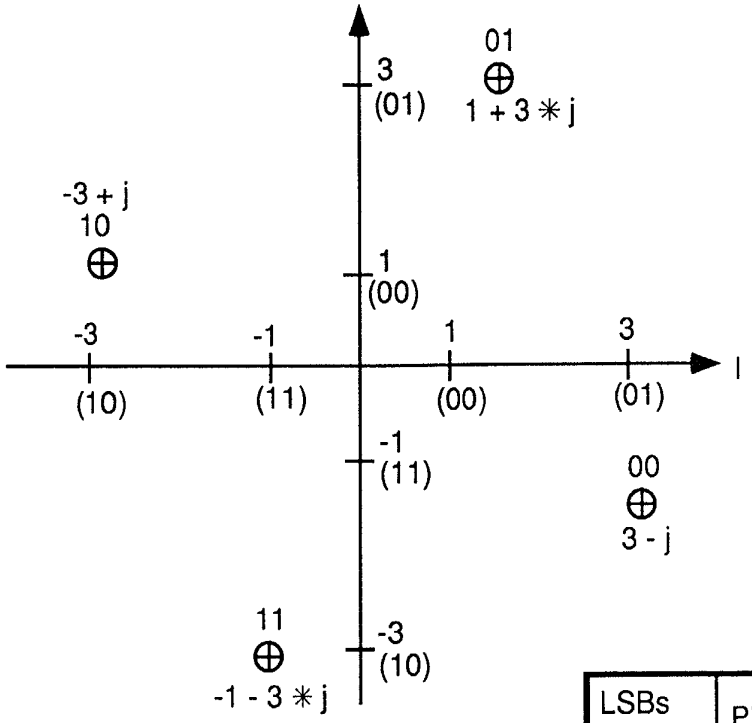


FIG. 21

LSBs y1 y0	PHASE	1+jQ
00	0	3-j
01	90	1+j3
10	180	-3+j
11	-90	-1-j3

MSBs y3 y2	PHASE difference (2nd-1st symbol)	1+jQ WHEN LSB=00	1+jQ WHEN LSB=01	1+jQ WHEN LSB=10	1+jQ WHEN LSB=11
00	0	3-j	1+j3	-3+j	-1-j3
01	90	1+j3	-3+j	-1-j3	3-j
10	180	-3+j	-1-j3	3-j	1+j3
11	-90	-1-j3	3-j	1+j3	-3+j

LSB & MSB FALLBACK MODE MAPPINGS

FIG. 22

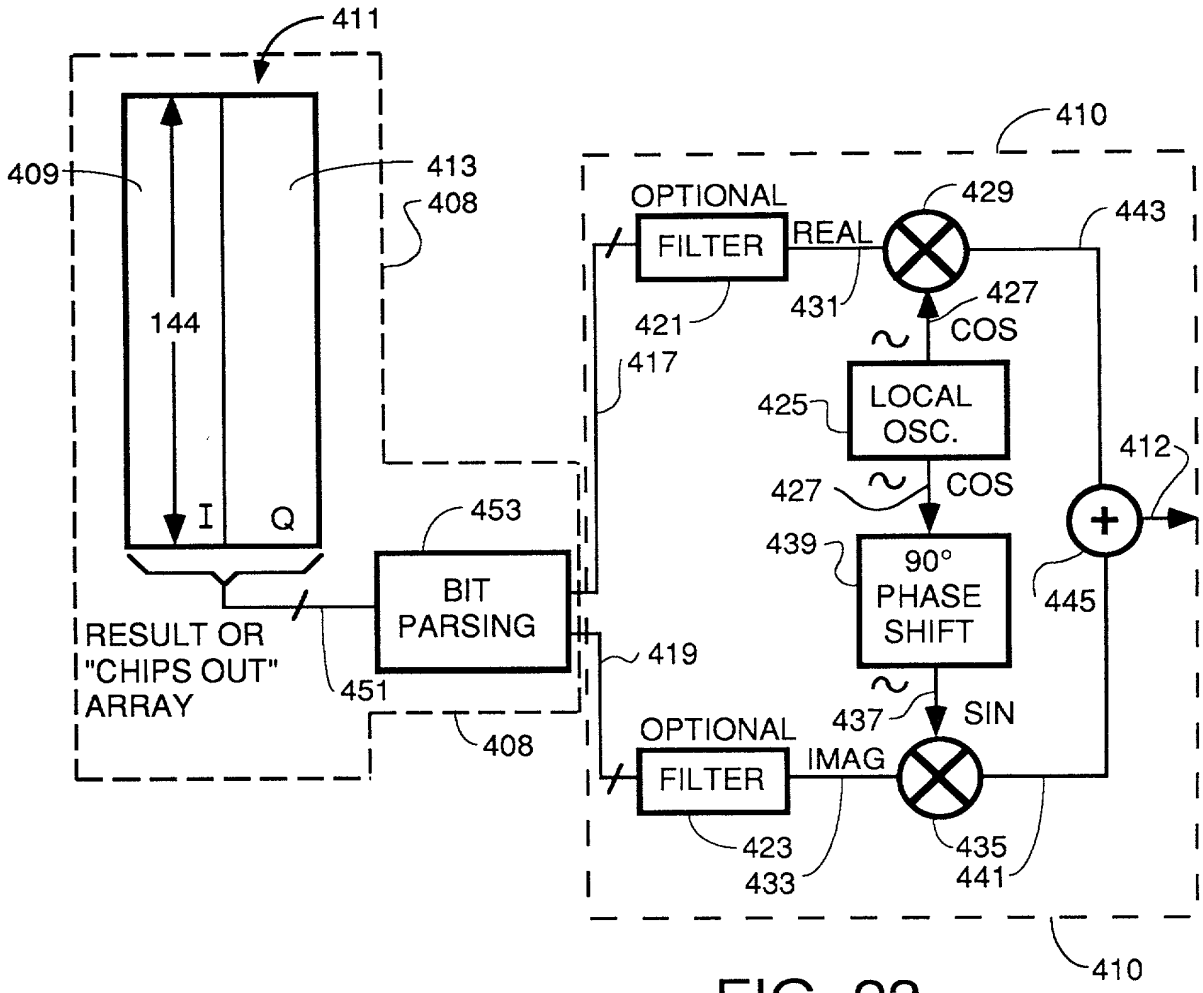

411
409
413
408
144
I
Q
453
BIT
PARSING
RESULT OR
"CHIPS OUT"
ARRAY
451
408
410
OPTIONAL
FILTER
REAL
429
443
421
431
427
COS
417
425
LOCAL
OSC.
412
427
COS
439
90°
PHASE
SHIFT
445
419
437
SIN
OPTIONAL
FILTER
IMAG
423
433
435
441
410

FIG. 23

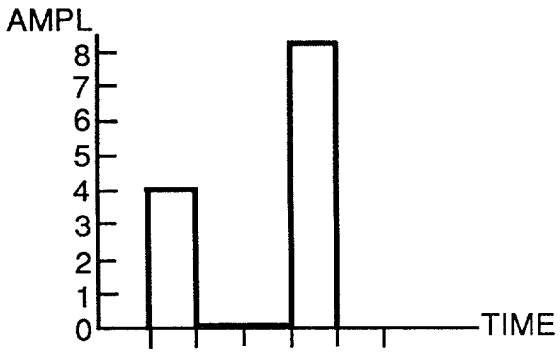
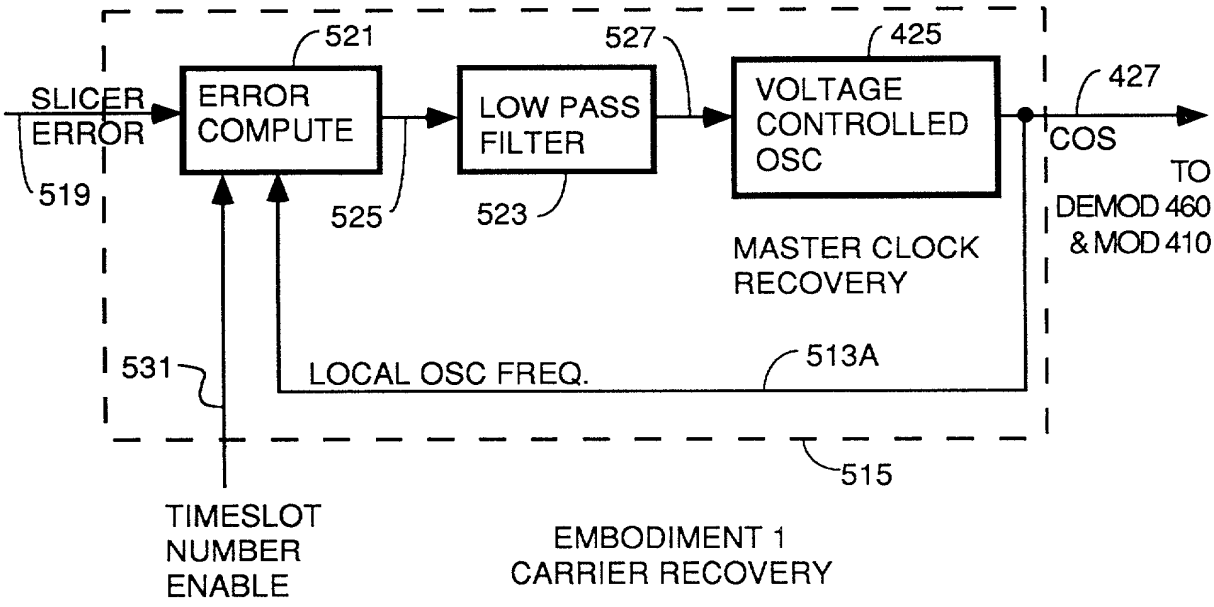
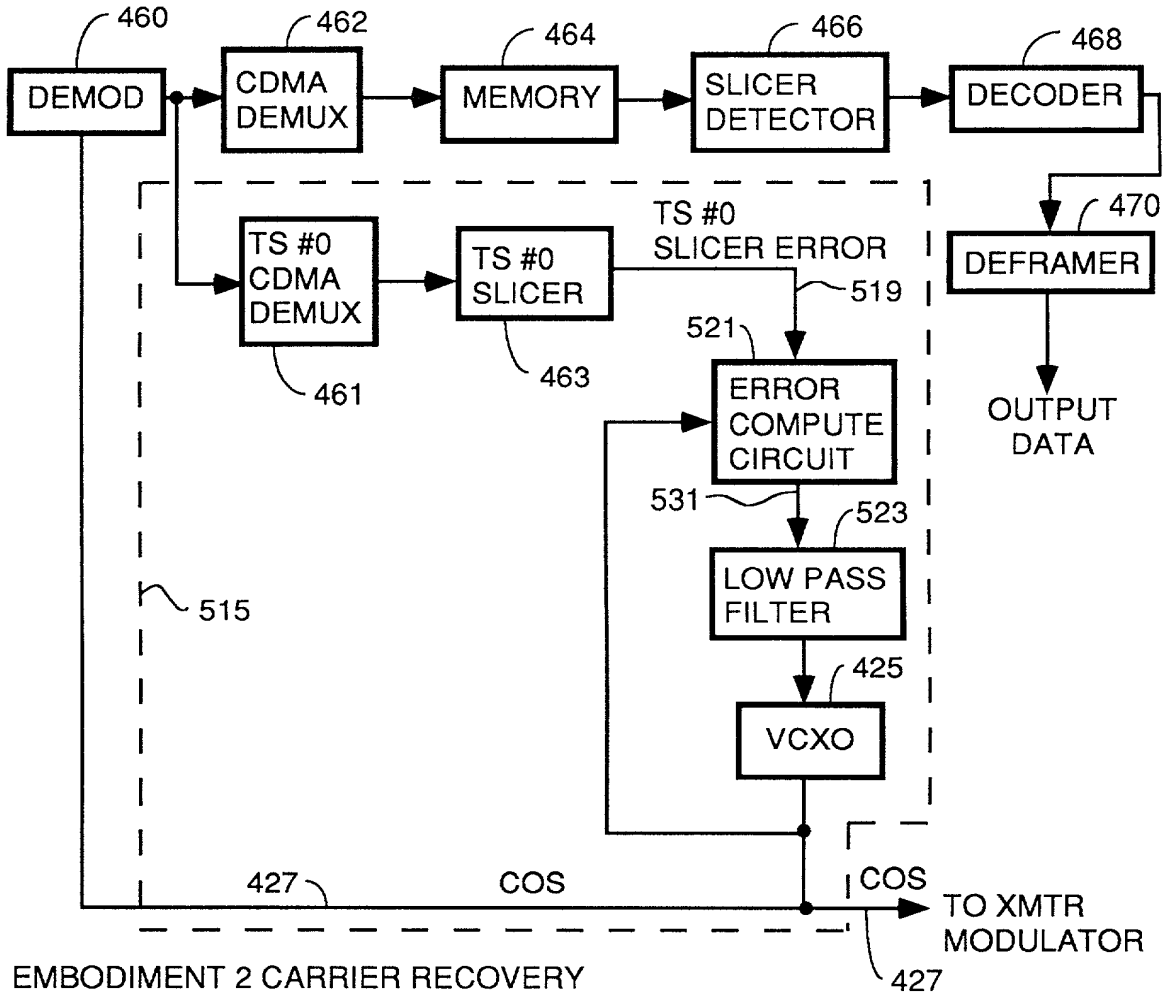

AMPL
8
7
6
5
4
3
2
1
0
TIME

FIG. 24



EMBODIMENT 1 CARRIER RECOVERY

FIG. 25



EMBODIMENT 2 CARRIER RECOVERY

FIG. 26

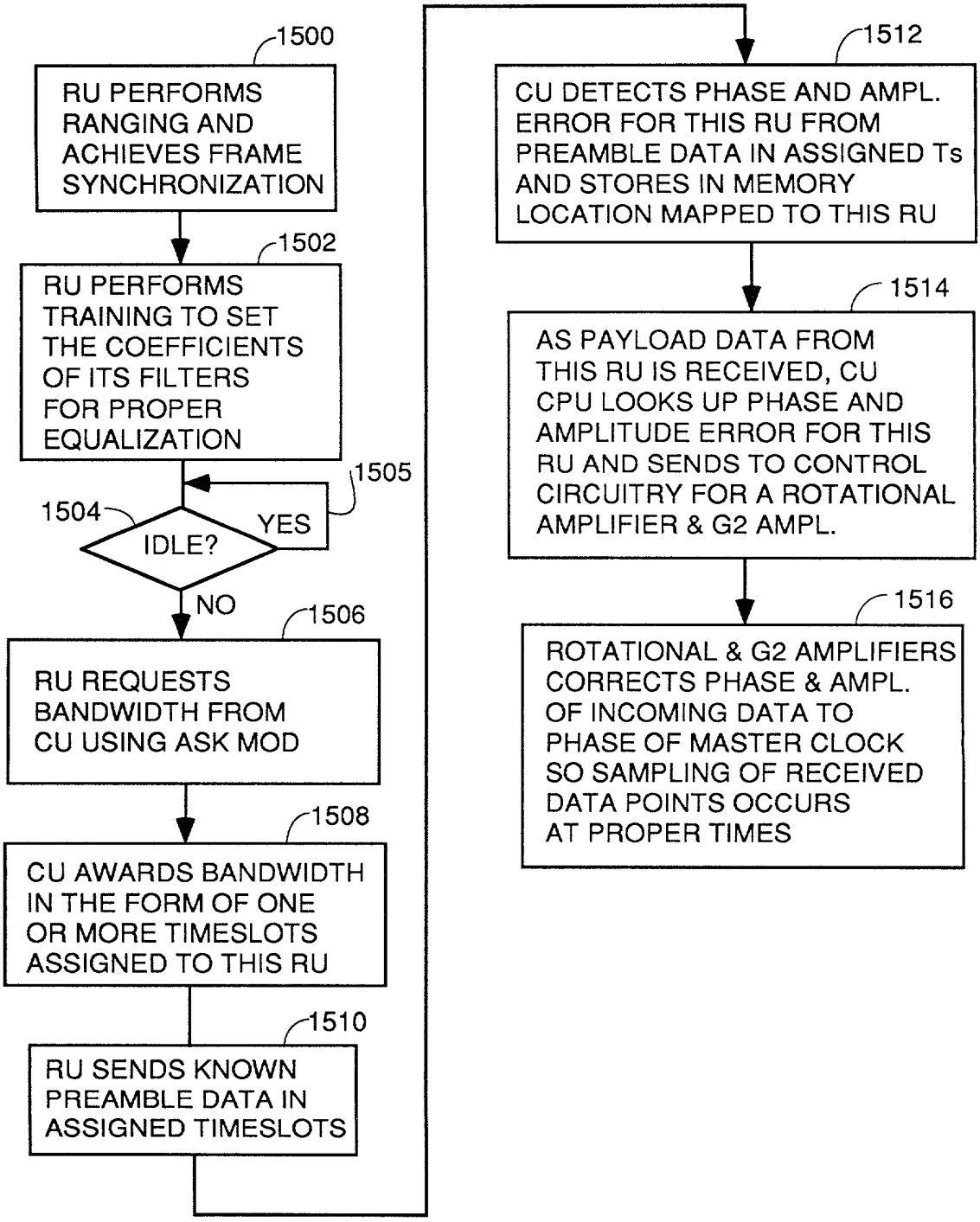
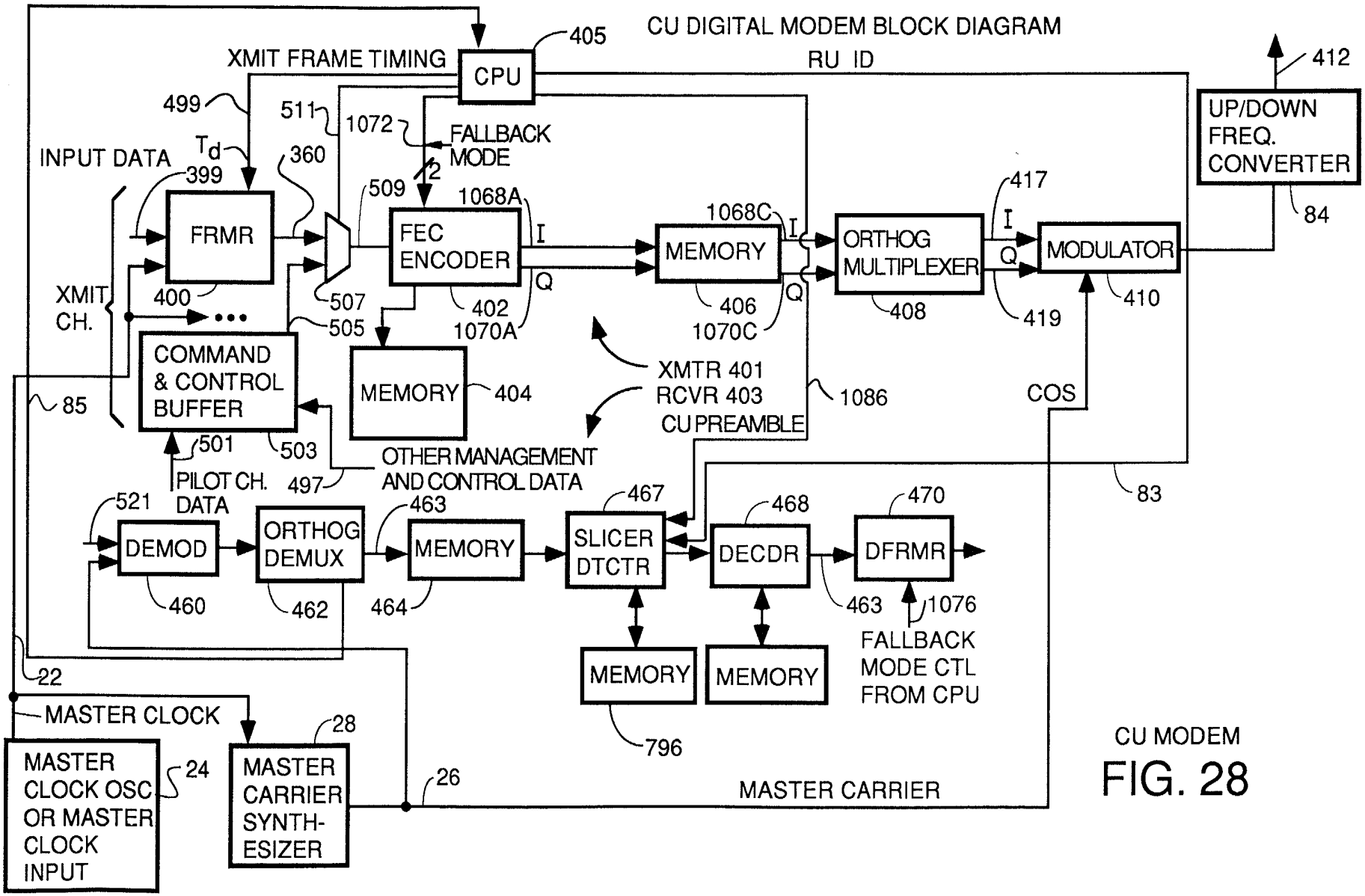

1500
RU PERFORMS RANGING AND ACHIEVES FRAME SYNCHRONIZATION
1502
RU PERFORMS TRAINING TO SET THE COEFFICIENTS OF ITS FILTERS FOR PROPER EQUALIZATION
1505
1504
IDLE?
YES
NO
1506
RU REQUESTS BANDWIDTH FROM CU USING ASK MOD
1508
CU AWARDS BANDWIDTH IN THE FORM OF ONE OR MORE TIMESLOTS ASSIGNED TO THIS RU
1510
RU SENDS KNOWN PREAMBLE DATA IN ASSIGNED TIMESLOTS
1512
CU DETECTS PHASE AND AMPL. ERROR FOR THIS RU FROM PREAMBLE DATA IN ASSIGNED Ts AND STORES IN MEMORY LOCATION MAPPED TO THIS RU
1514
AS PAYLOAD DATA FROM THIS RU IS RECEIVED, CU CPU LOOKS UP PHASE AND AMPLITUDE ERROR FOR THIS RU AND SENDS TO CONTROL CIRCUITRY FOR A ROTATIONAL AMPLIFIER & G2 AMPL.
1516
ROTATIONAL & G2 AMPLIFIERS CORRECTS PHASE & AMPL. OF INCOMING DATA TO PHASE OF MASTER CLOCK SO SAMPLING OF RECEIVED DATA POINTS OCCURS AT PROPER TIMES

FIG. 27



CU MODEM

FIG. 28

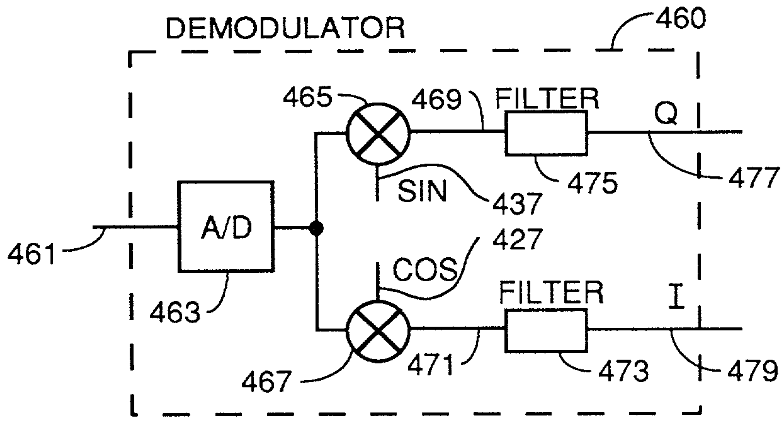

DEMODULATOR
460
465
469
FILTER
Q
SIN
437
475
477
461
A/D
427
COS
FILTER
I
463
467
471
473
479

FIG. 29

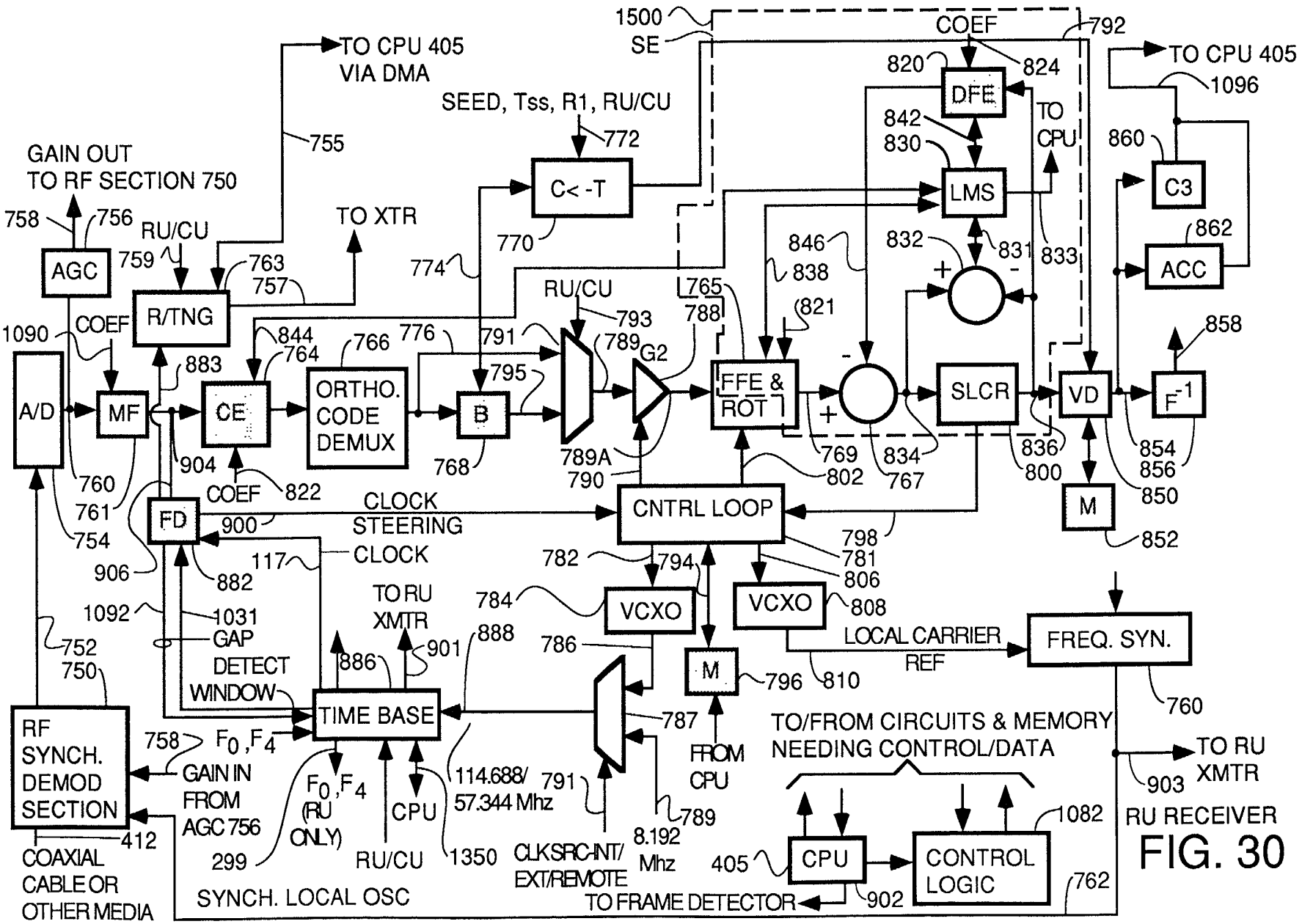
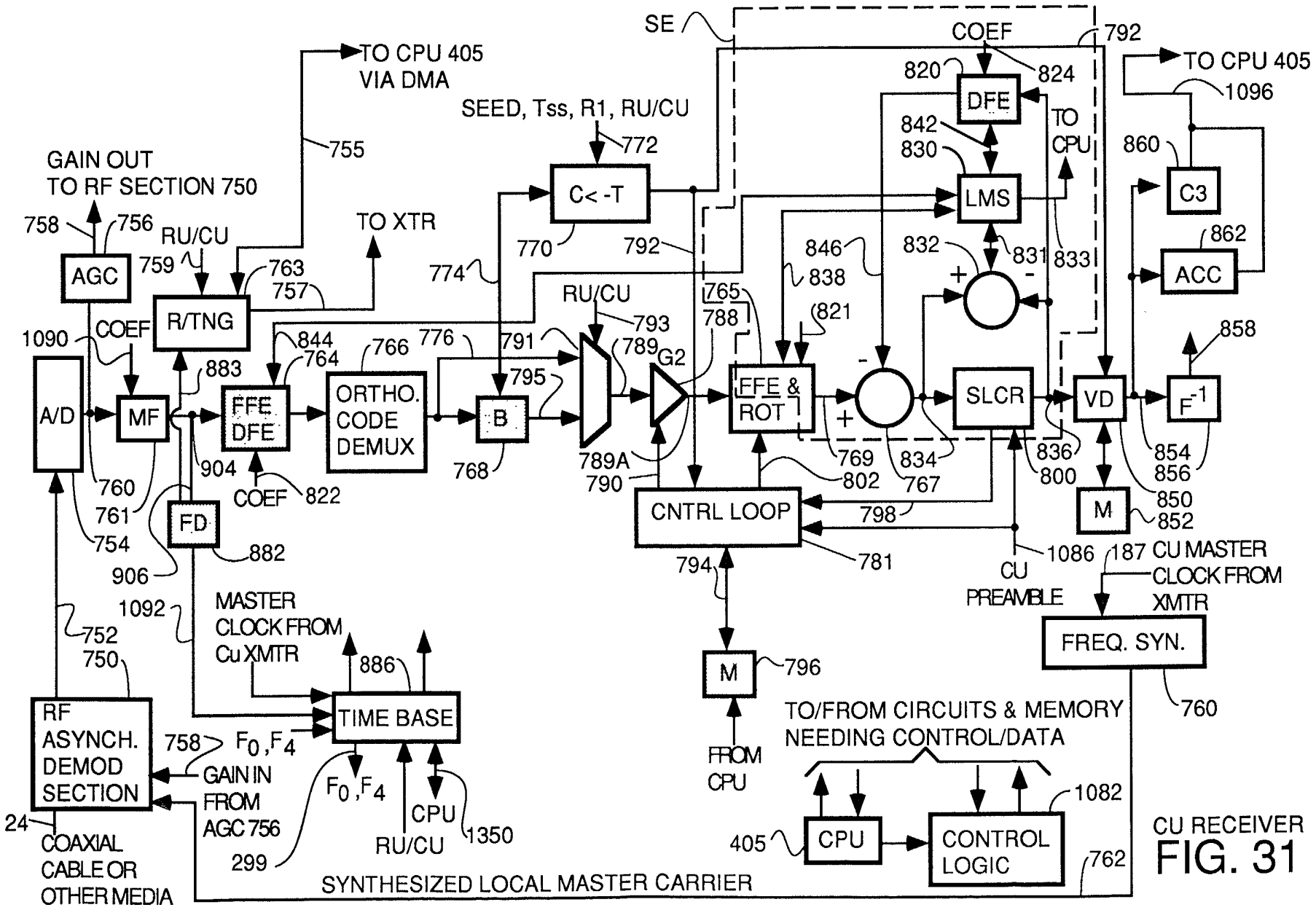
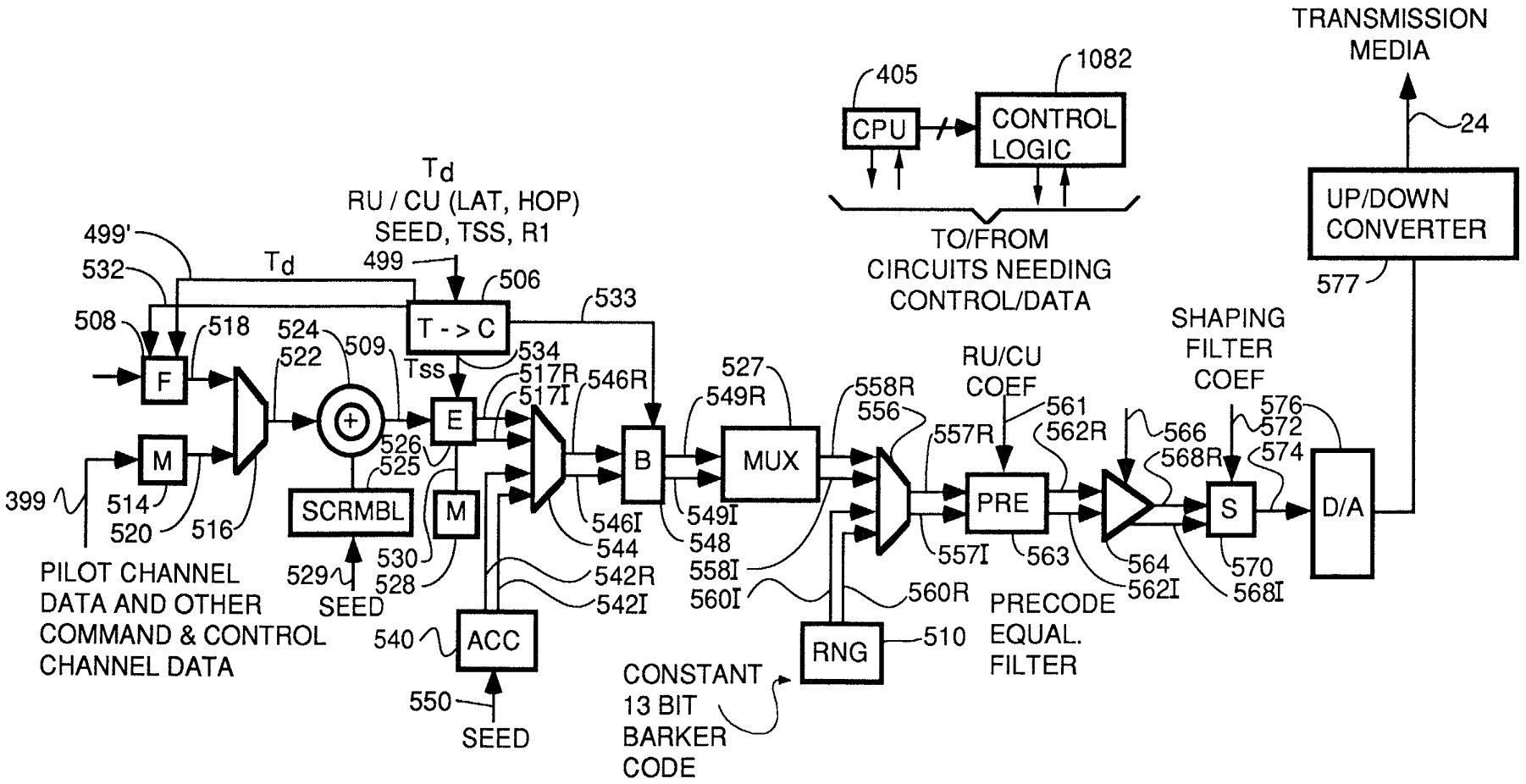


FIG. 30



CU RECEIVER

FIG. 31



CU TRANSMITTER

FIG. 32

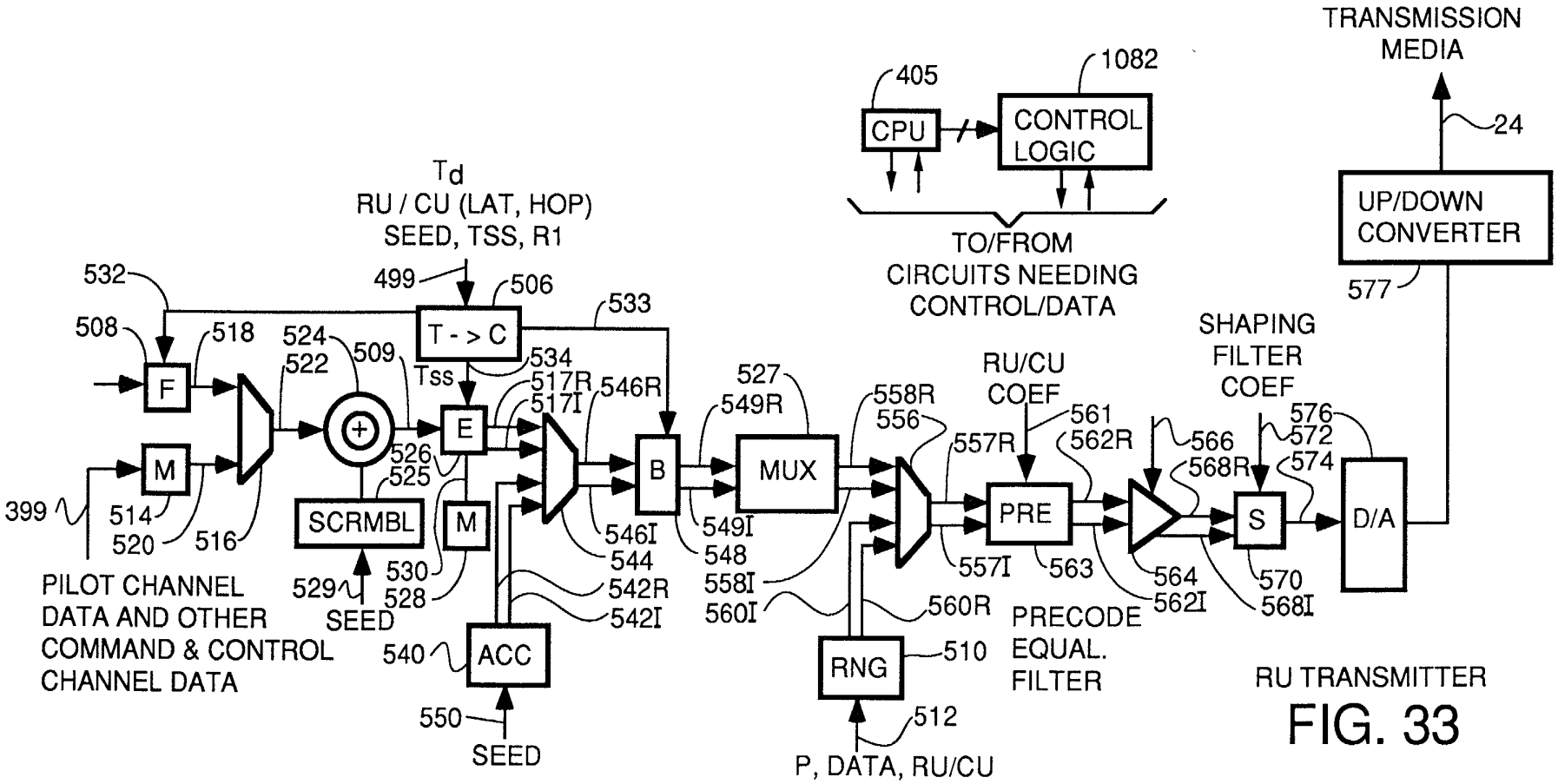


FIG. 33

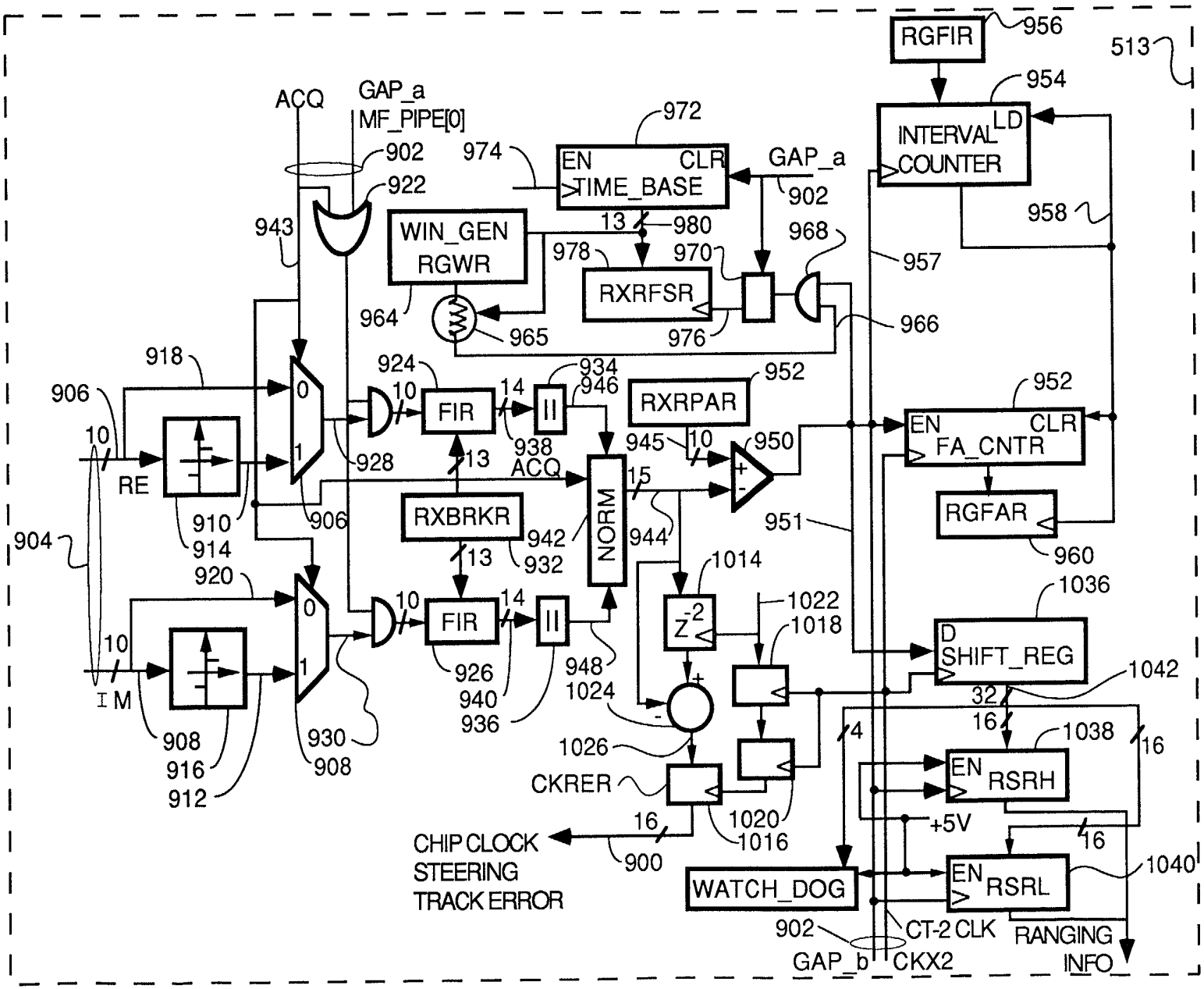


FIG. 34

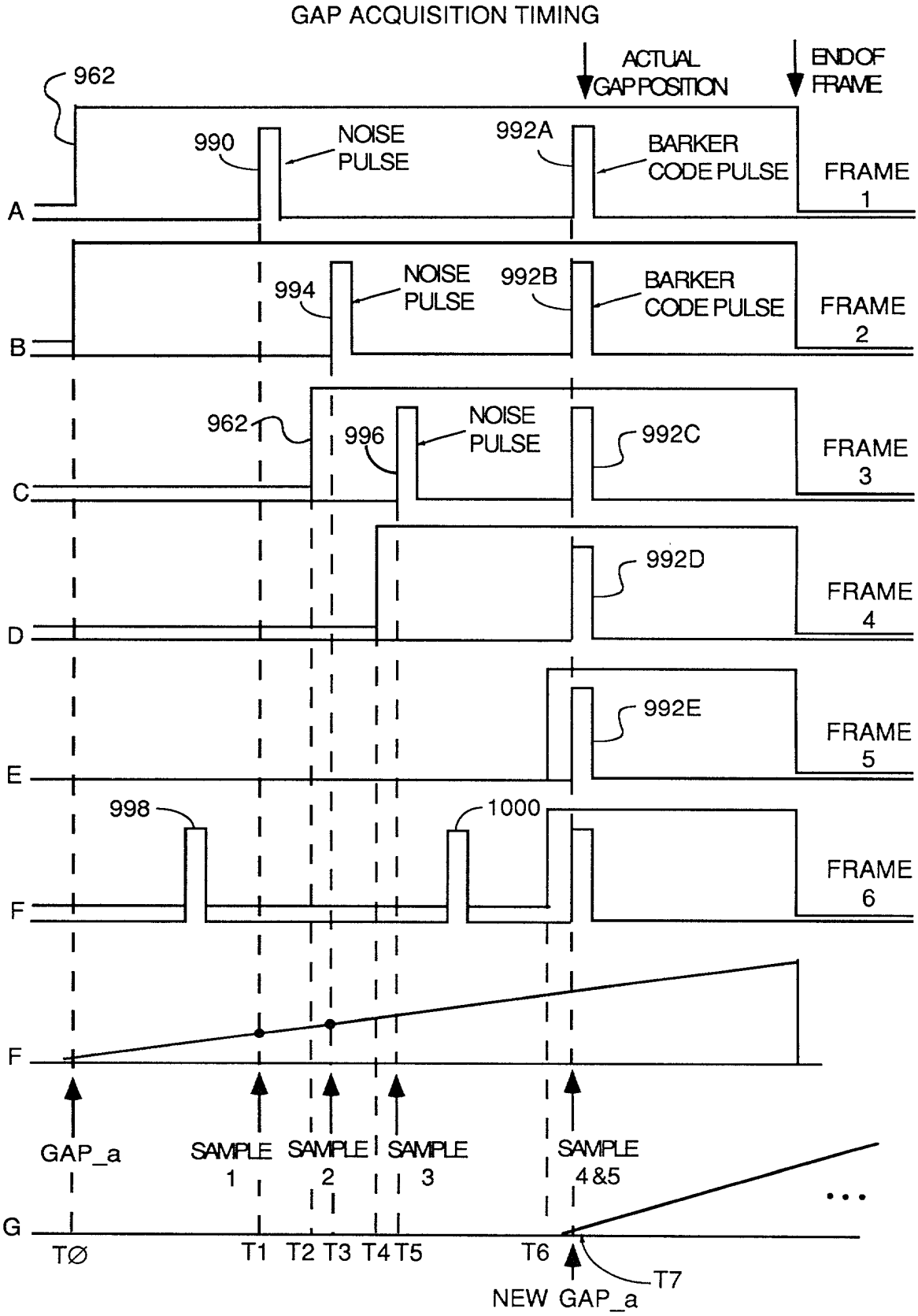

GAP ACQUISITION TIMING
ACTUAL GAP POSITION
END OF FRAME
962
990
NOISE PULSE
992A
BARKER CODE PULSE
FRAME 1
A
994
NOISE PULSE
992B
BARKER CODE PULSE
FRAME 2
B
962
996
NOISE PULSE
992C
FRAME 3
C
992D
FRAME 4
D
992E
FRAME 5
E
998
1000
FRAME 6
F
F
GAP_a
SAMPLE 1
SAMPLE 2
SAMPLE 3
SAMPLE 4&5
G
TØ
T1 T2 T3 T4 T5
T6
T7
NEW GAP_a

FIG. 35

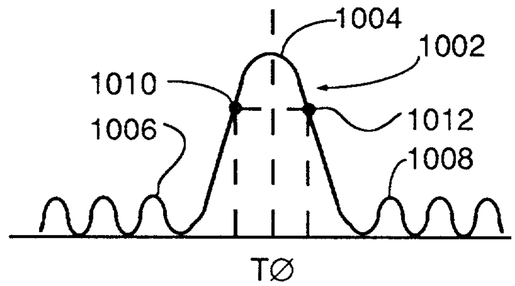


FIG. 36

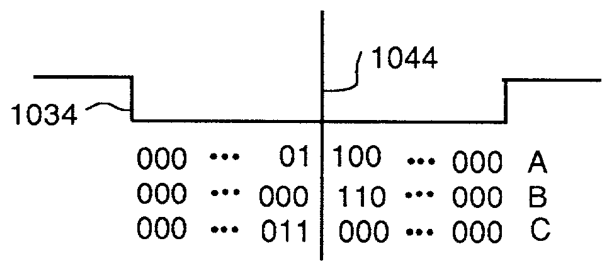


FIG. 37
FINE TUNING TO
CENTER BARKER CODE

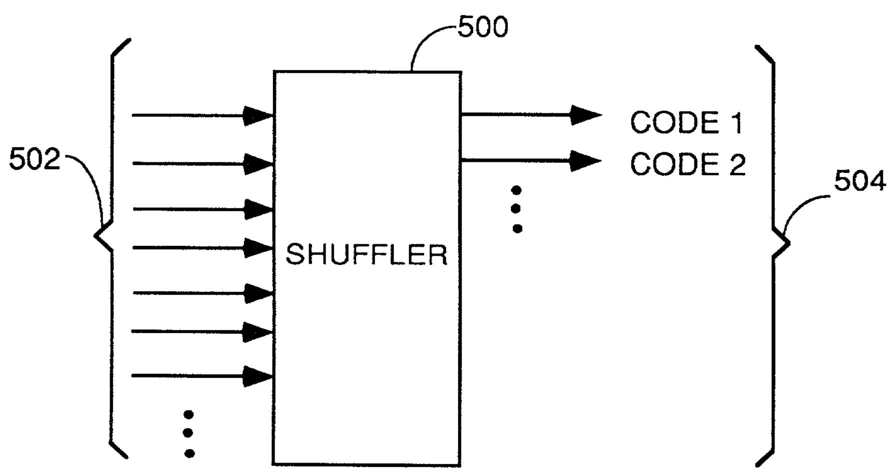


FIG. 38

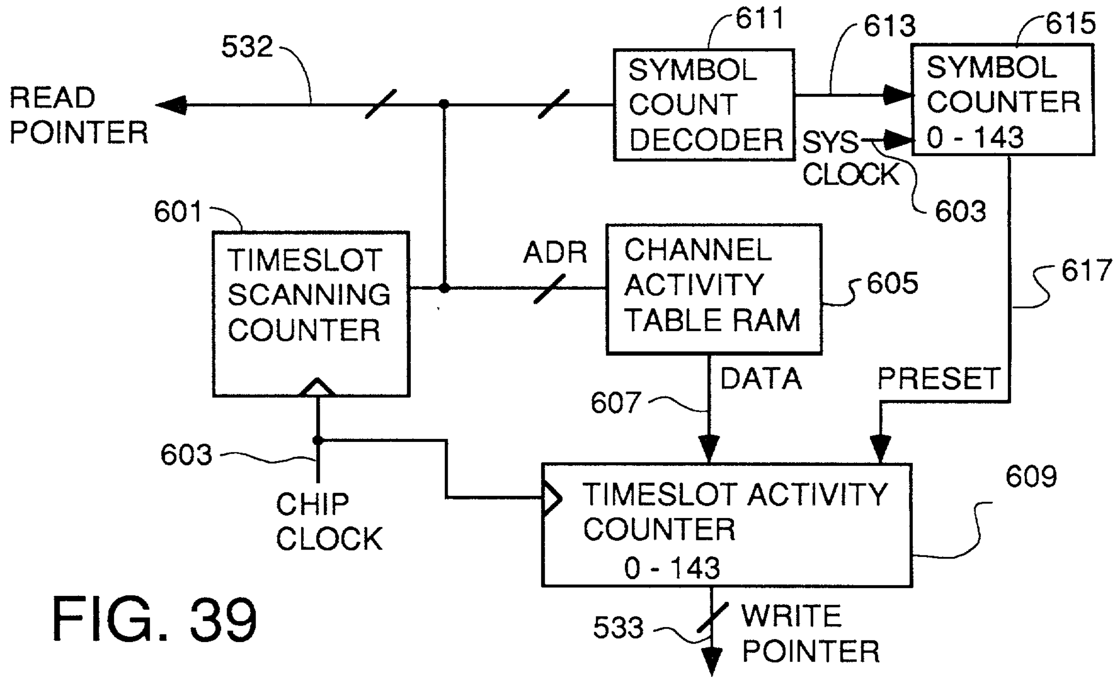


FIG. 39

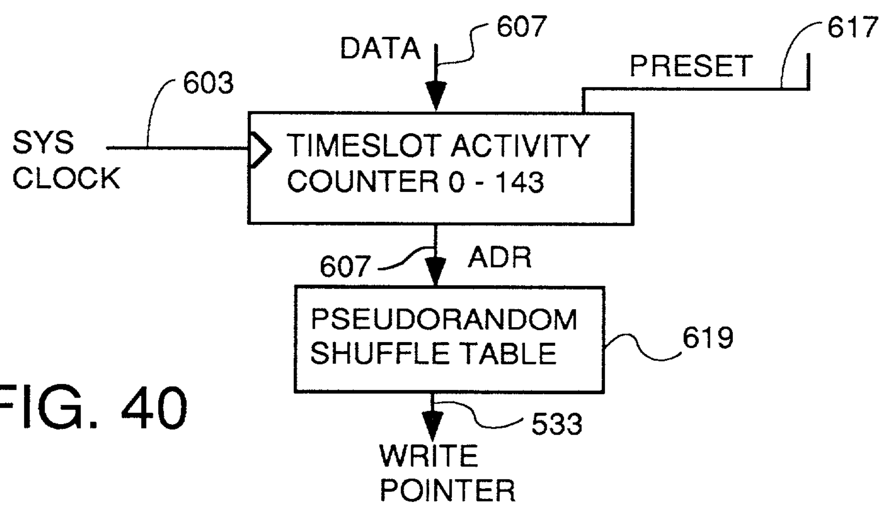


FIG. 40

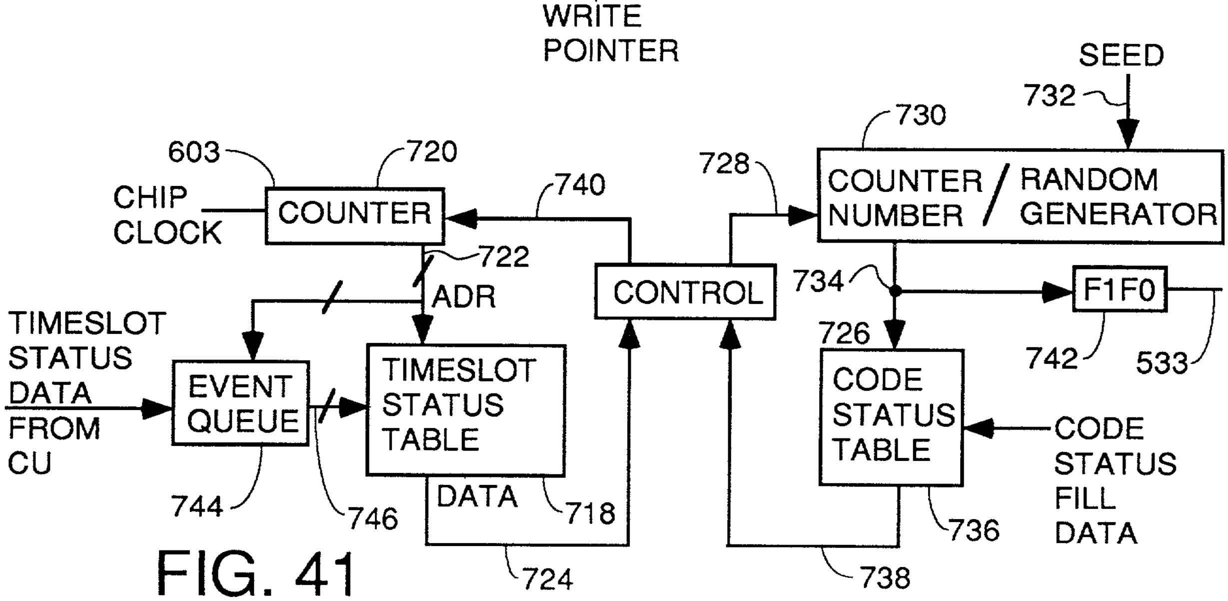

SEED
732
730
603
720
728
740
CHIP CLOCK
COUNTER
COUNTER NUMBER / RANDOM GENERATOR
722
734
ADR
CONTROL
F1F0
TIMESLOT STATUS DATA FROM CU
726
EVENT QUEUE
TIMESLOT STATUS TABLE
742
533
CODE STATUS TABLE
CODE STATUS FILL DATA
DATA
744
746
718
736
724
738

FIG. 41

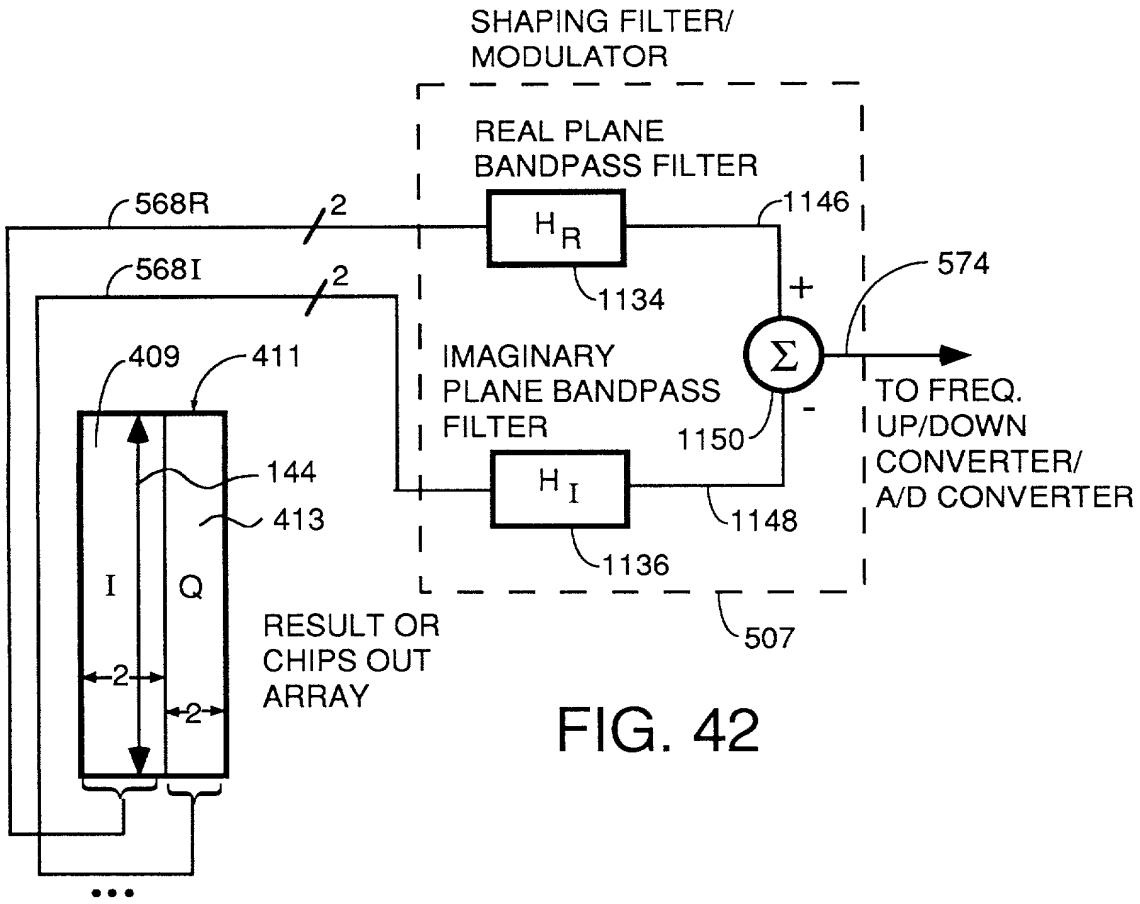


FIG. 42

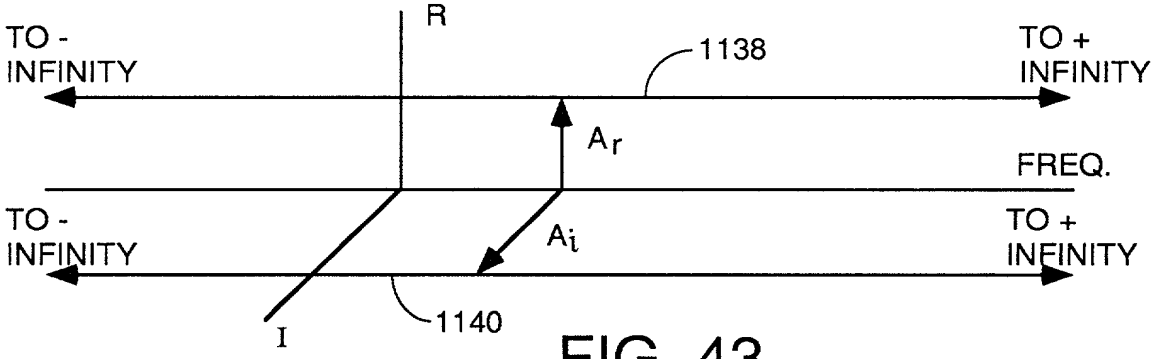


FIG. 43

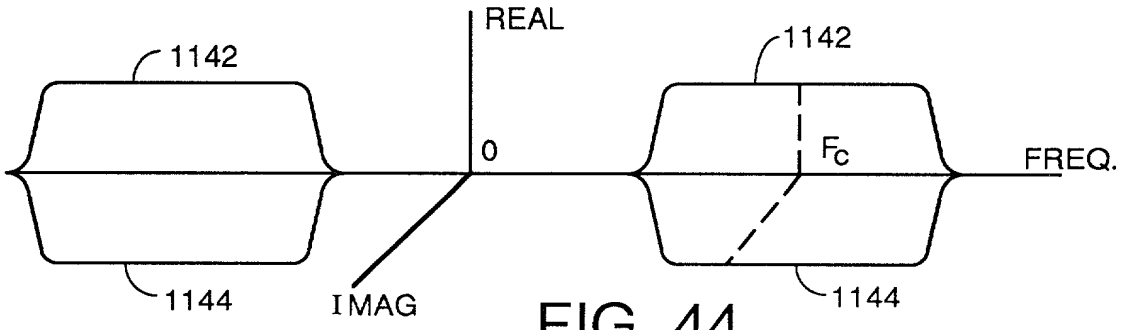
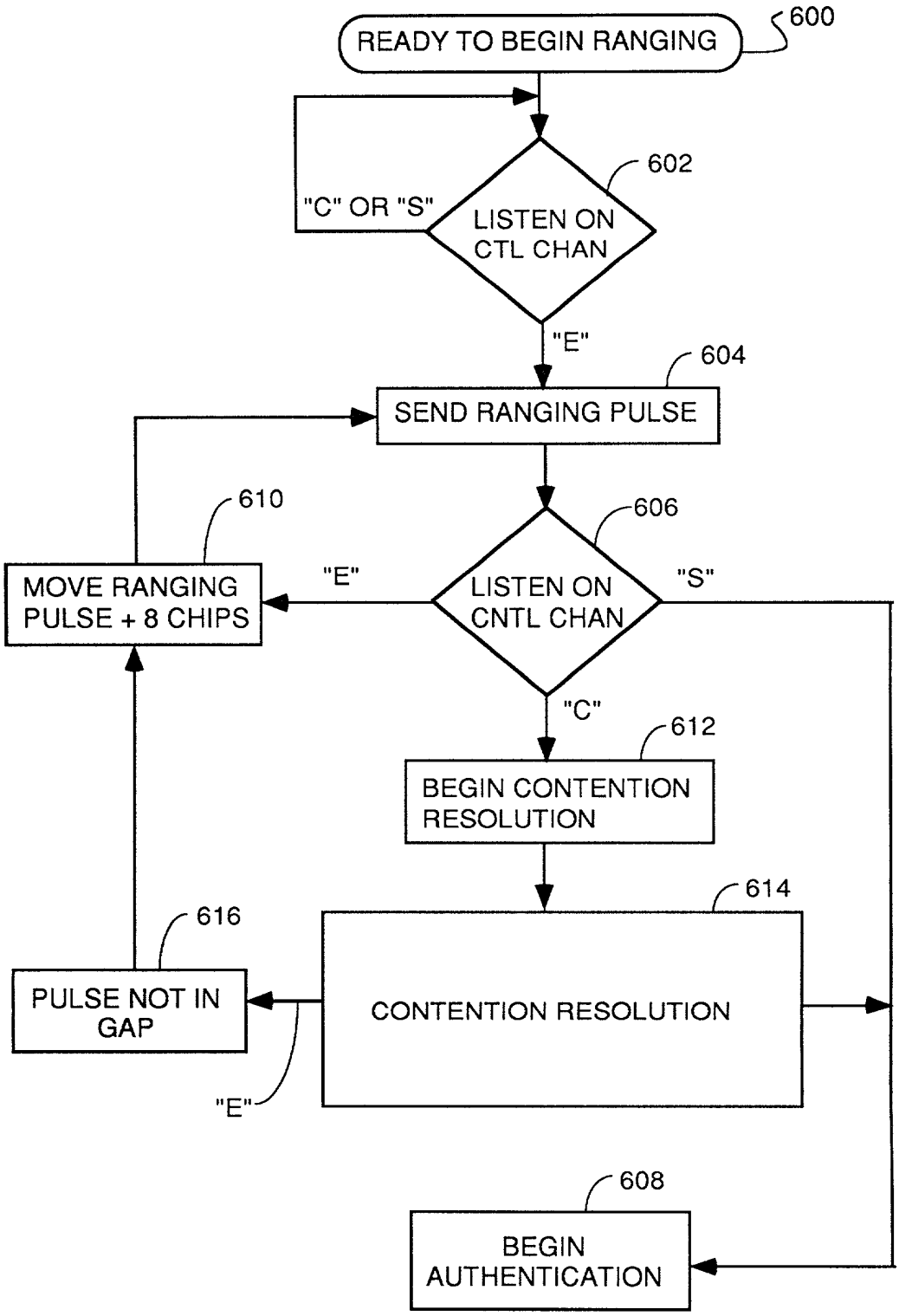
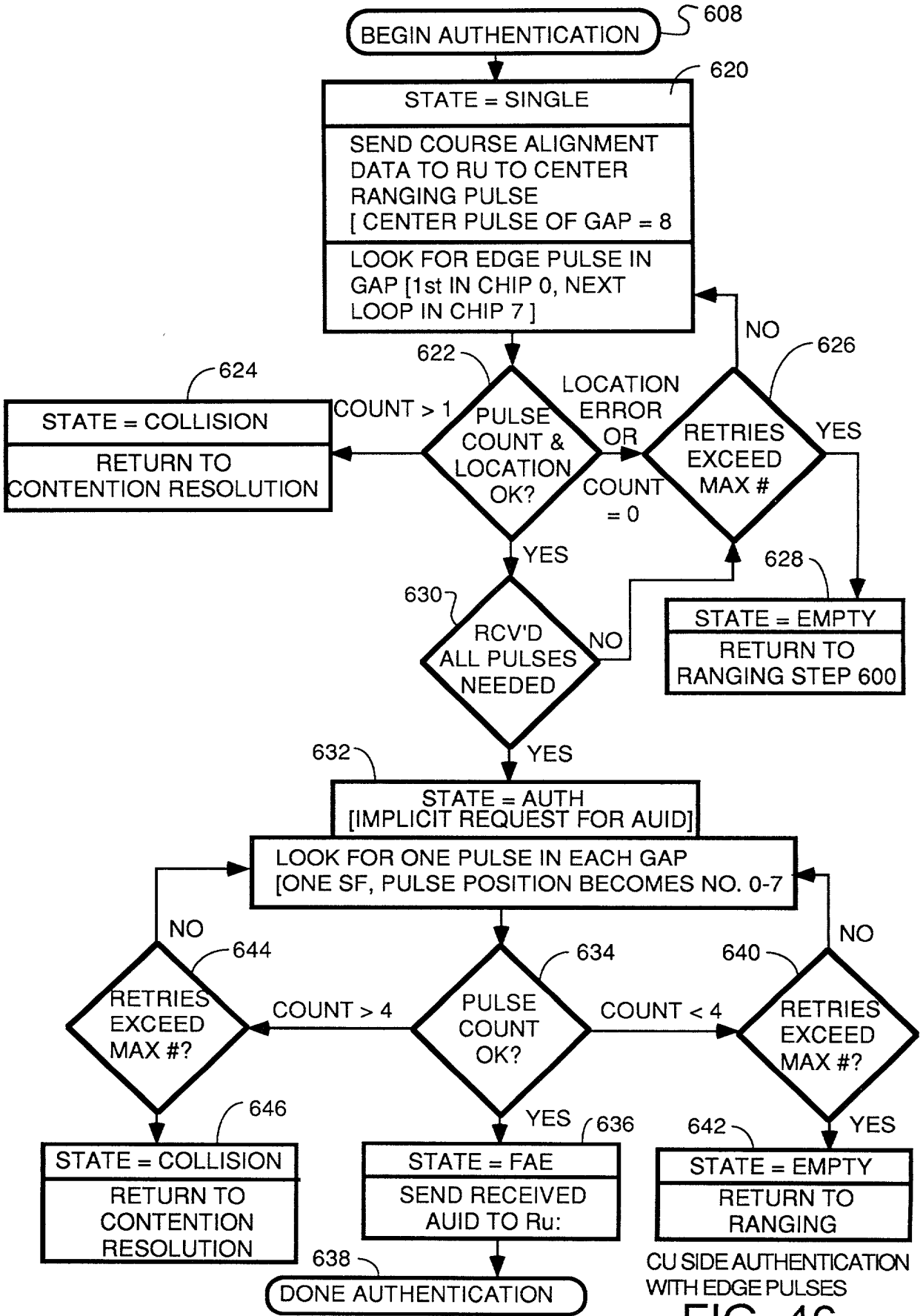


FIG. 44



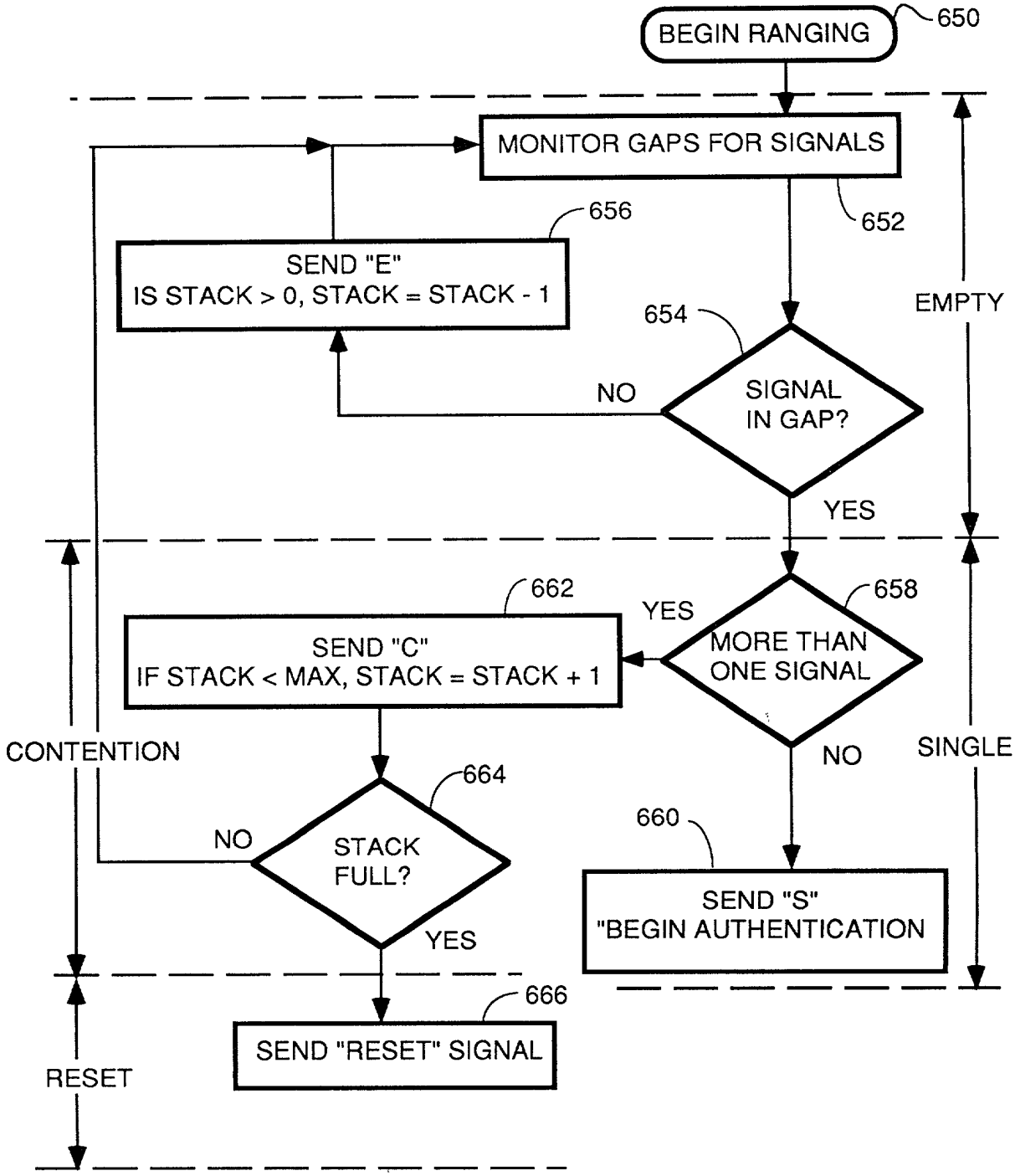
RU RANGING

FIG. 45



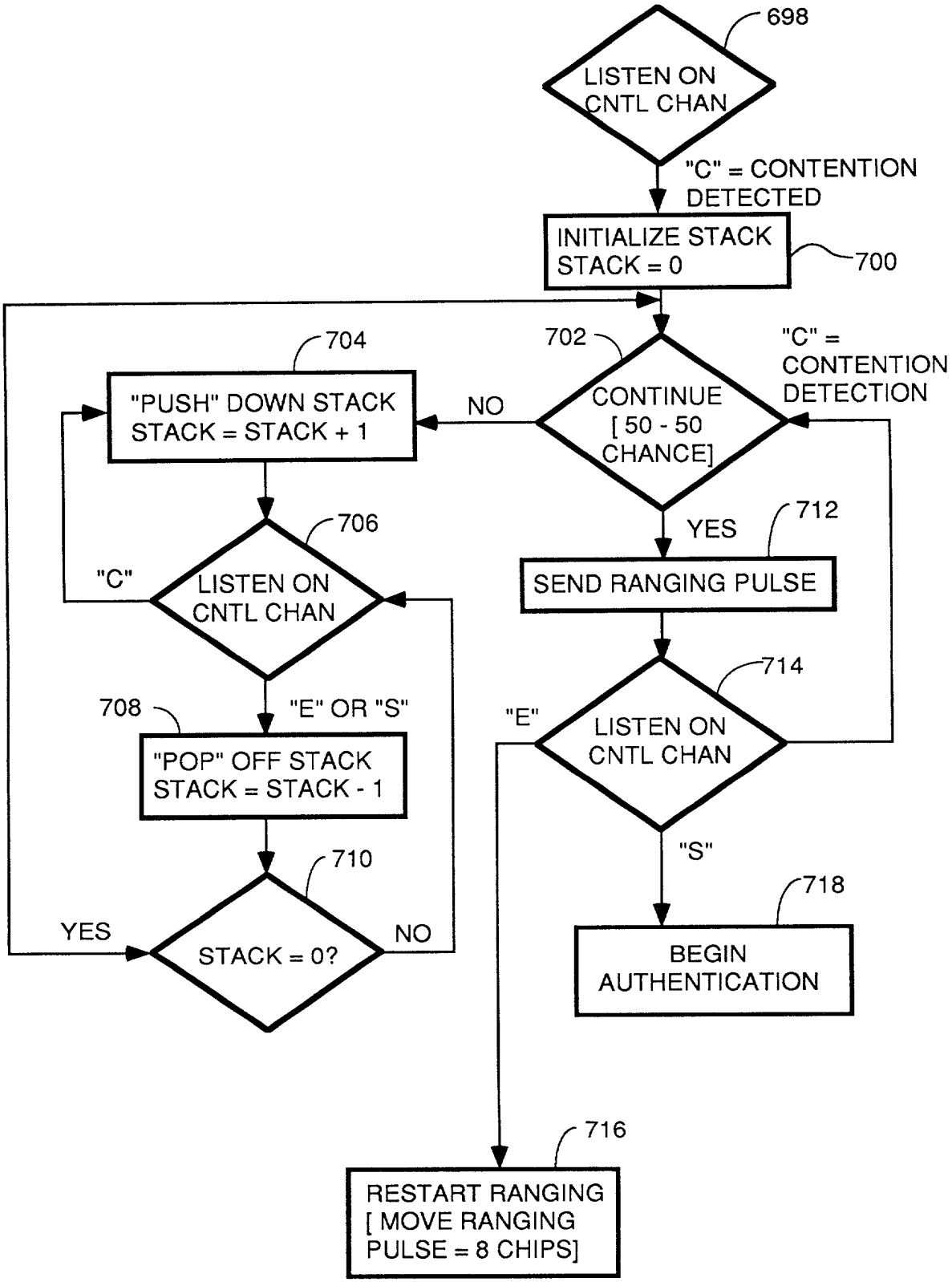
CU SIDE AUTHENTICATION WITH EDGE PULSES

FIG. 46



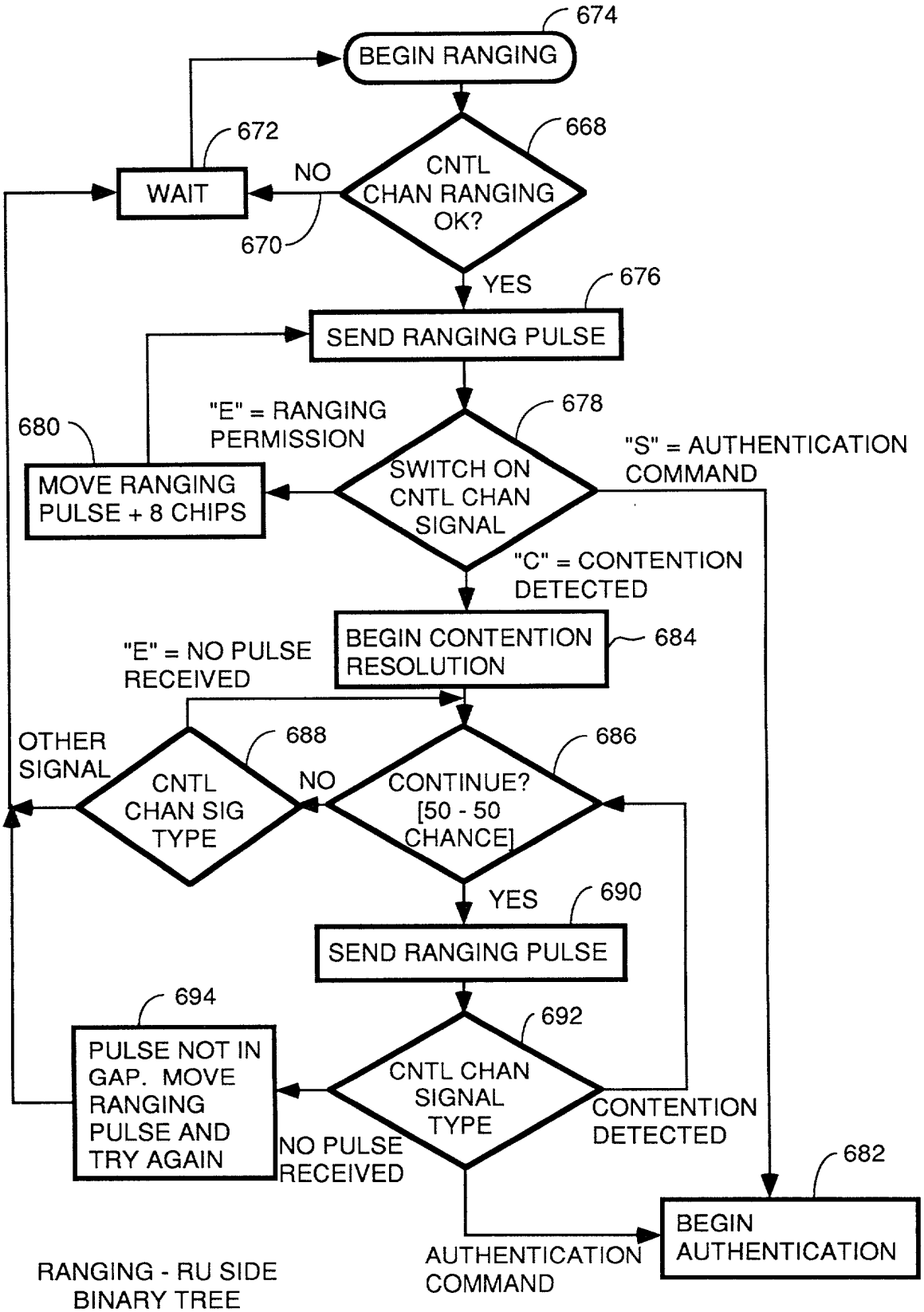
CU RANGING AND CONTENTION RESOLUTION

FIG. 47



CONTENTION RESOLUTION - RU USING BINARY STACK

FIG. 48



RANGING - RU SIDE BINARY TREE ALGORITHM

FIG. 49

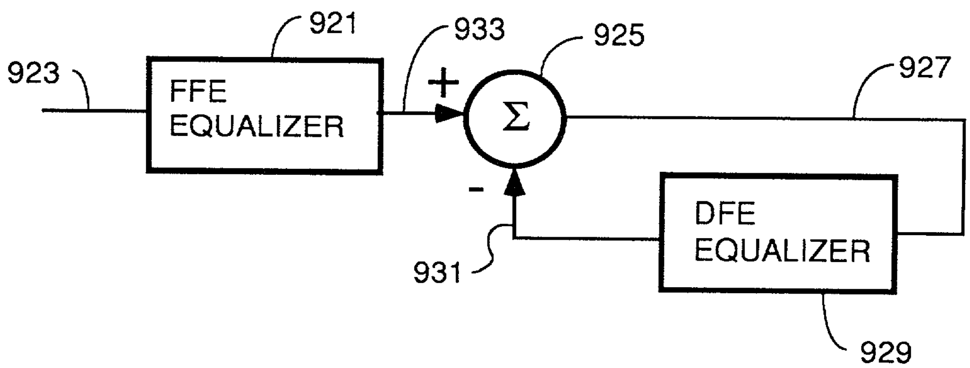


FIG. 50

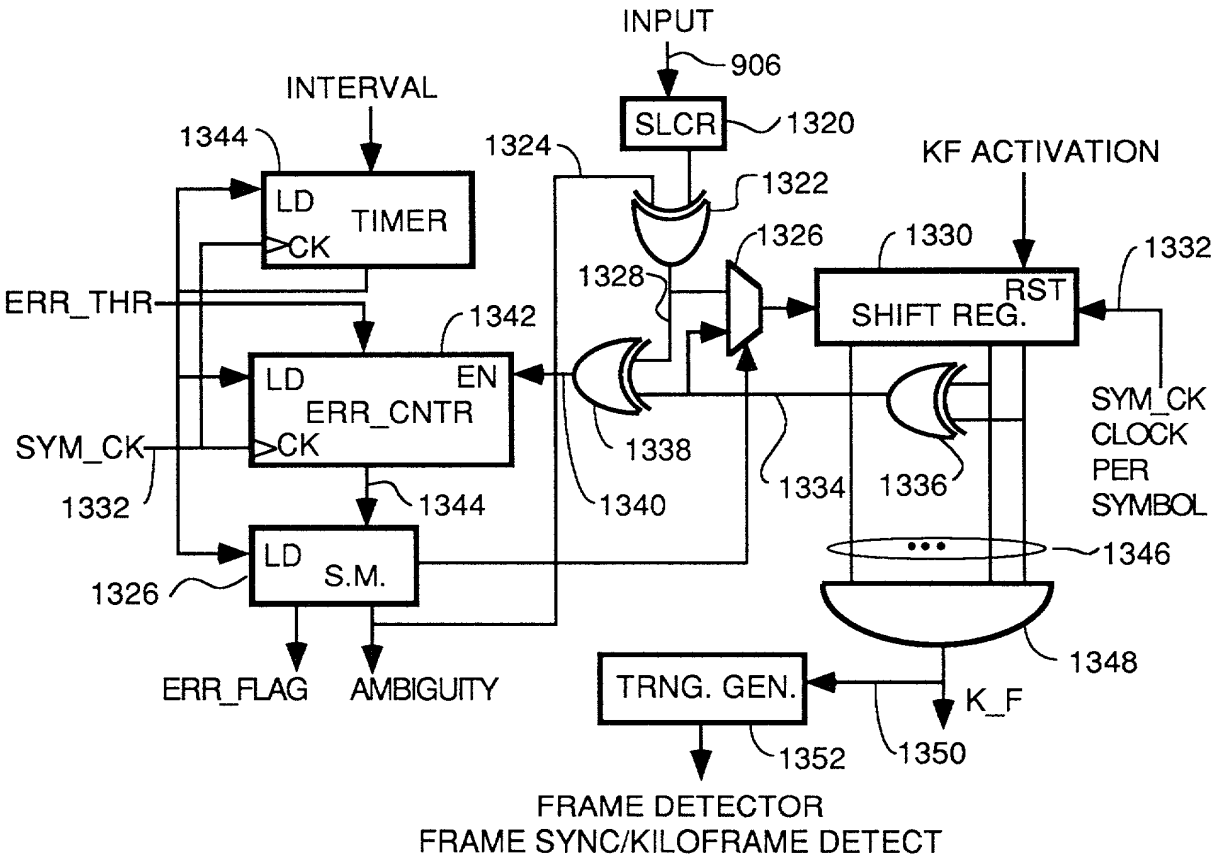
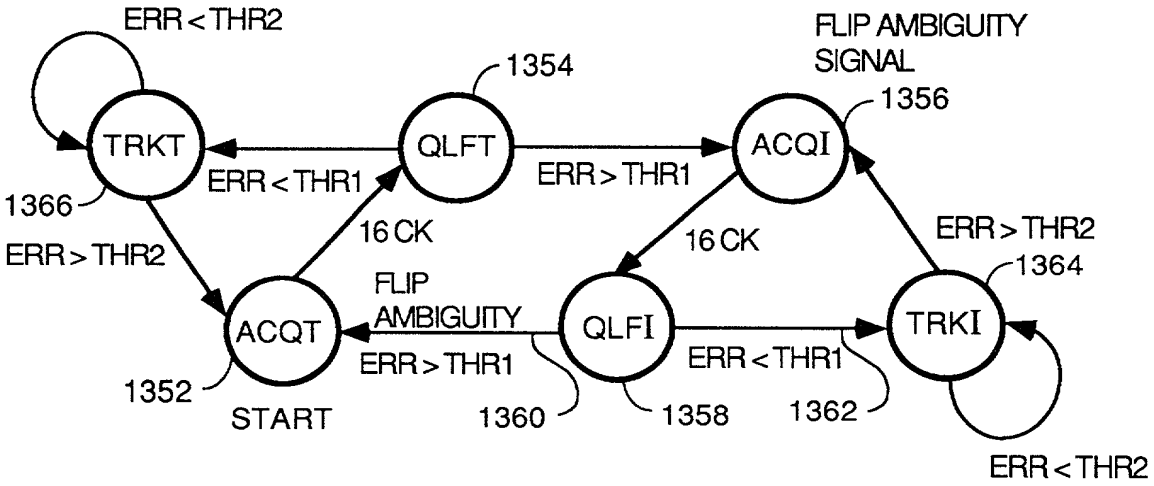


FIG. 51



STATE MACHINE

FIG. 52

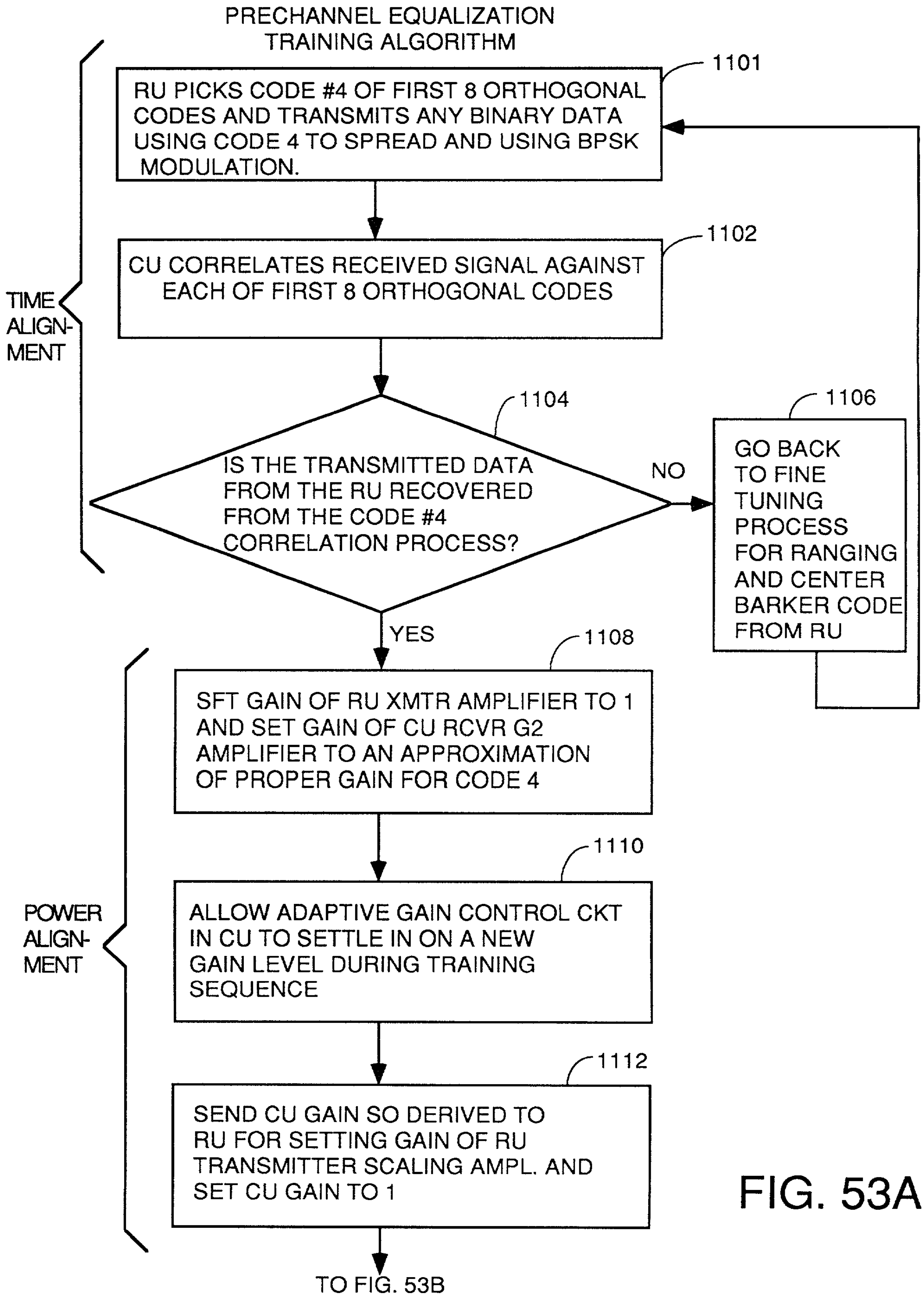

PRECHANNEL EQUALIZATION
TRAINING ALGORITHM
1101
RU PICKS CODE #4 OF FIRST 8 ORTHOGONAL CODES AND TRANSMITS ANY BINARY DATA USING CODE 4 TO SPREAD AND USING BPSK MODULATION.
1102
CU CORRELATES RECEIVED SIGNAL AGAINST EACH OF FIRST 8 ORTHOGONAL CODES
TIME ALIGN-MENT
1104
IS THE TRANSMITTED DATA FROM THE RU RECOVERED FROM THE CODE #4 CORRELATION PROCESS?
NO
1106
GO BACK TO FINE TUNING PROCESS FOR RANGING AND CENTER BARKER CODE FROM RU
YES
1108
SFT GAIN OF RU XMTR AMPLIFIER TO 1 AND SET GAIN OF CU RCVR G2 AMPLIFIER TO AN APPROXIMATION OF PROPER GAIN FOR CODE 4
1110
ALLOW ADAPTIVE GAIN CONTROL CKT IN CU TO SETTLE IN ON A NEW GAIN LEVEL DURING TRAINING SEQUENCE
POWER ALIGN-MENT
1112
SEND CU GAIN SO DERIVED TO RU FOR SETTING GAIN OF RU TRANSMITTER SCALING AMPL. AND SET CU GAIN TO 1
TO FIG. 53B

FIG. 53A

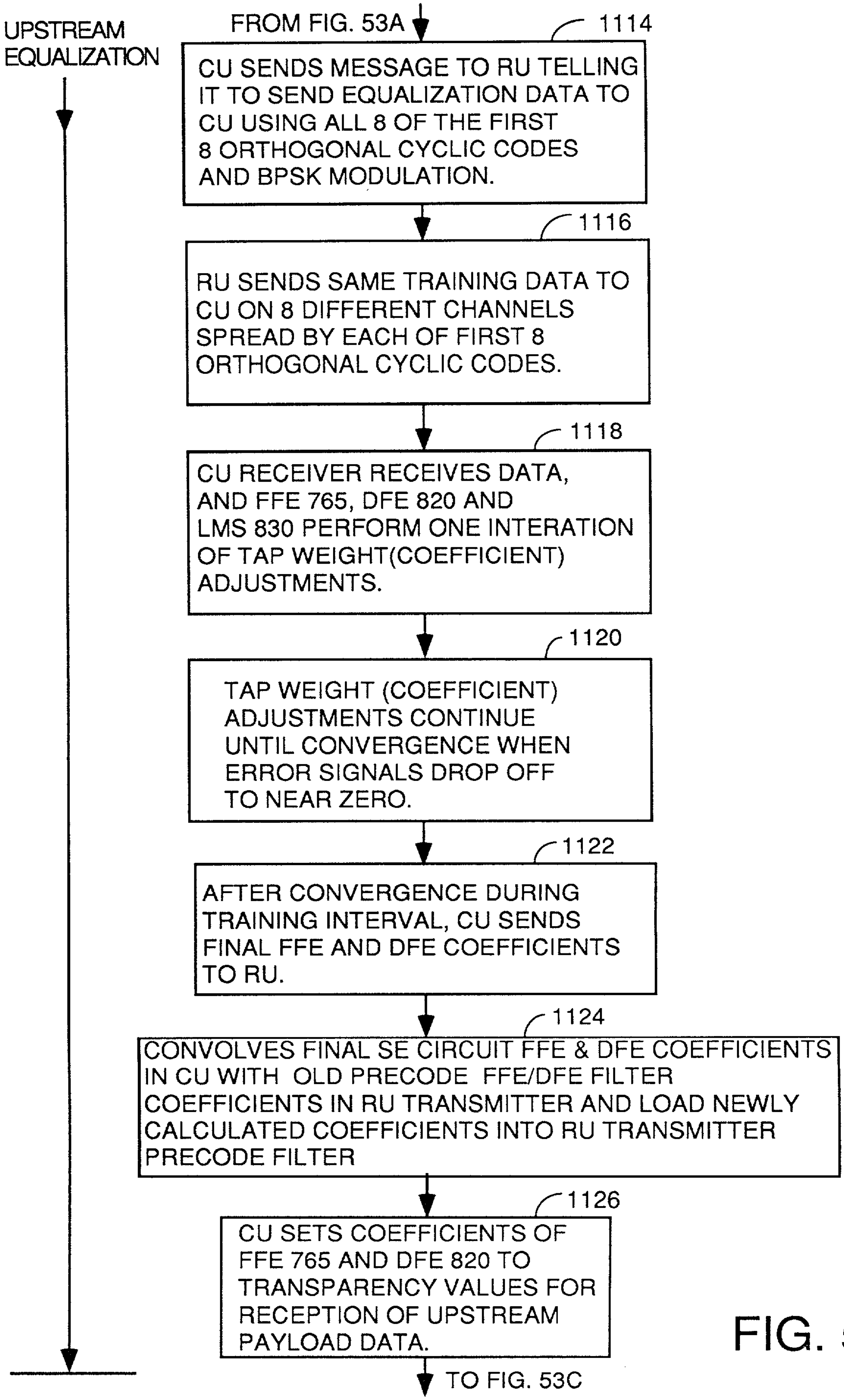

UPSTREAM EQUALIZATION
FROM FIG. 53A
1114
CU SENDS MESSAGE TO RU TELLING IT TO SEND EQUALIZATION DATA TO CU USING ALL 8 OF THE FIRST 8 ORTHOGONAL CYCLIC CODES AND BPSK MODULATION.
1116
RU SENDS SAME TRAINING DATA TO CU ON 8 DIFFERENT CHANNELS SPREAD BY EACH OF FIRST 8 ORTHOGONAL CYCLIC CODES.
1118
CU RECEIVER RECEIVES DATA, AND FFE 765, DFE 820 AND LMS 830 PERFORM ONE INTERATION OF TAP WEIGHT(COEFFICIENT) ADJUSTMENTS.
1120
TAP WEIGHT (COEFFICIENT) ADJUSTMENTS CONTINUE UNTIL CONVERGENCE WHEN ERROR SIGNALS DROP OFF TO NEAR ZERO.
1122
AFTER CONVERGENCE DURING TRAINING INTERVAL, CU SENDS FINAL FFE AND DFE COEFFICIENTS TO RU.
1124
CONVOLVES FINAL SE CIRCUIT FFE & DFE COEFFICIENTS IN CU WITH OLD PRECODE FFE/DFE FILTER COEFFICIENTS IN RU TRANSMITTER AND LOAD NEWLY CALCULATED COEFFICIENTS INTO RU TRANSMITTER PRECODE FILTER
1126
CU SETS COEFFICIENTS OF FFE 765 AND DFE 820 TO TRANSPARENCY VALUES FOR RECEPTION OF UPSTREAM PAYLOAD DATA.
TO FIG. 53C

FIG. 53B

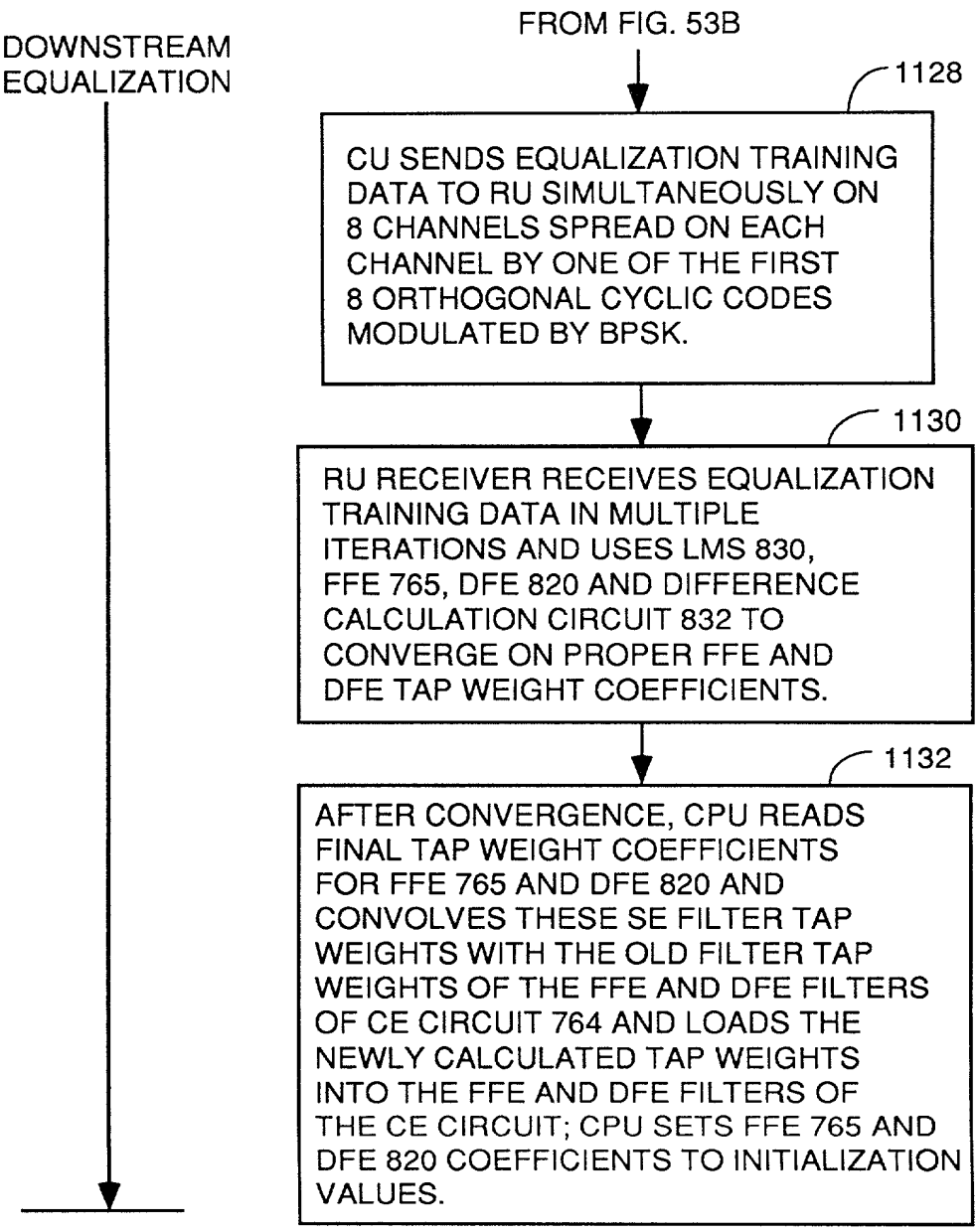

DOWNSTREAM EQUALIZATION
FROM FIG. 53B
1128
CU SENDS EQUALIZATION TRAINING DATA TO RU SIMULTANEOUSLY ON 8 CHANNELS SPREAD ON EACH CHANNEL BY ONE OF THE FIRST 8 ORTHOGONAL CYCLIC CODES MODULATED BY BPSK.
1130
RU RECEIVER RECEIVES EQUALIZATION TRAINING DATA IN MULTIPLE ITERATIONS AND USES LMS 830, FFE 765, DFE 820 AND DIFFERENCE CALCULATION CIRCUIT 832 TO CONVERGE ON PROPER FFE AND DFE TAP WEIGHT COEFFICIENTS.
1132
AFTER CONVERGENCE, CPU READS FINAL TAP WEIGHT COEFFICIENTS FOR FFE 765 AND DFE 820 AND CONVOLVES THESE SE FILTER TAP WEIGHTS WITH THE OLD FILTER TAP WEIGHTS OF THE FFE AND DFE FILTERS OF CE CIRCUIT 764 AND LOADS THE NEWLY CALCULATED TAP WEIGHTS INTO THE FFE AND DFE FILTERS OF THE CE CIRCUIT; CPU SETS FFE 765 AND DFE 820 COEFFICIENTS TO INITIALIZATION VALUES.

FIG. 53C

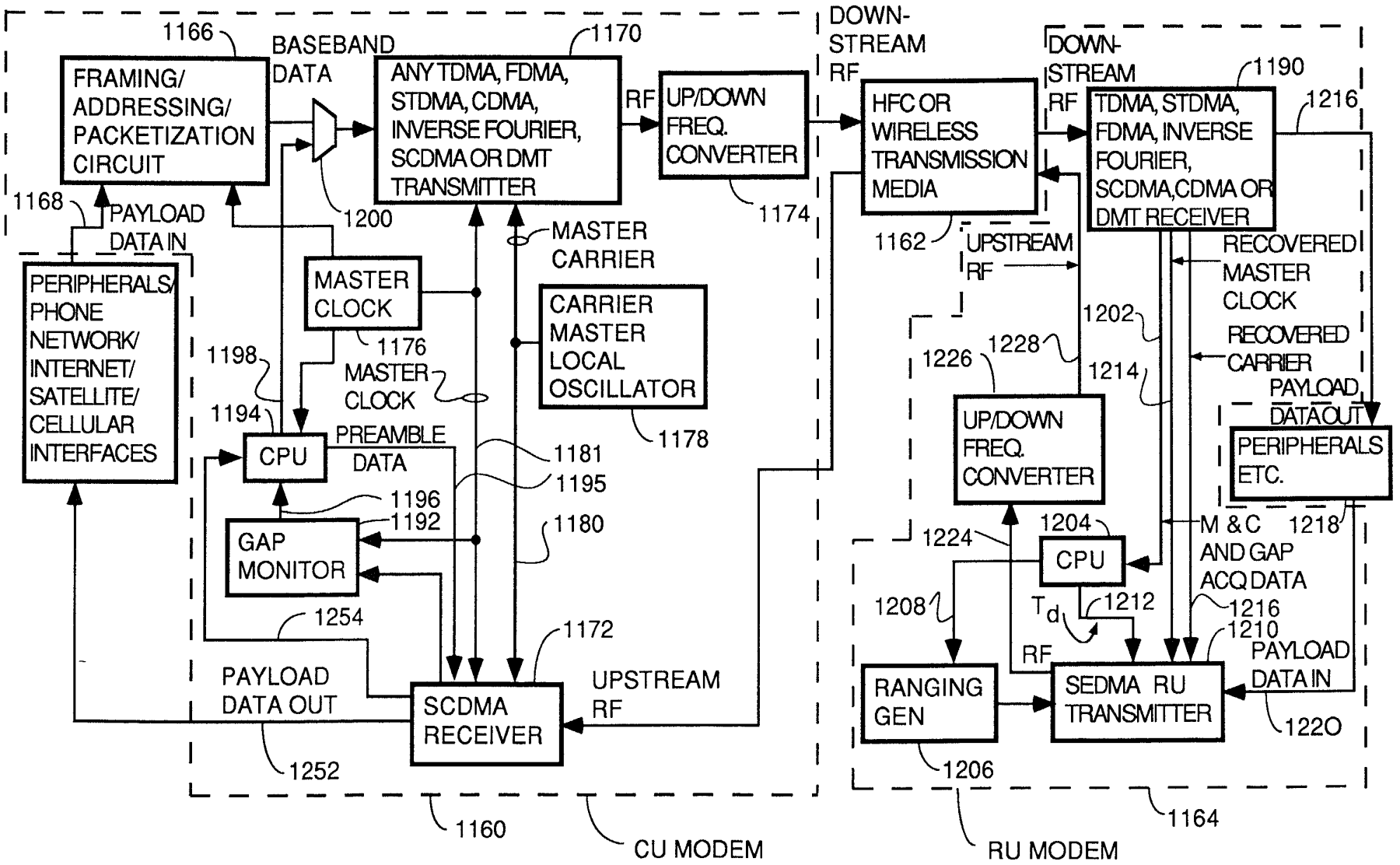
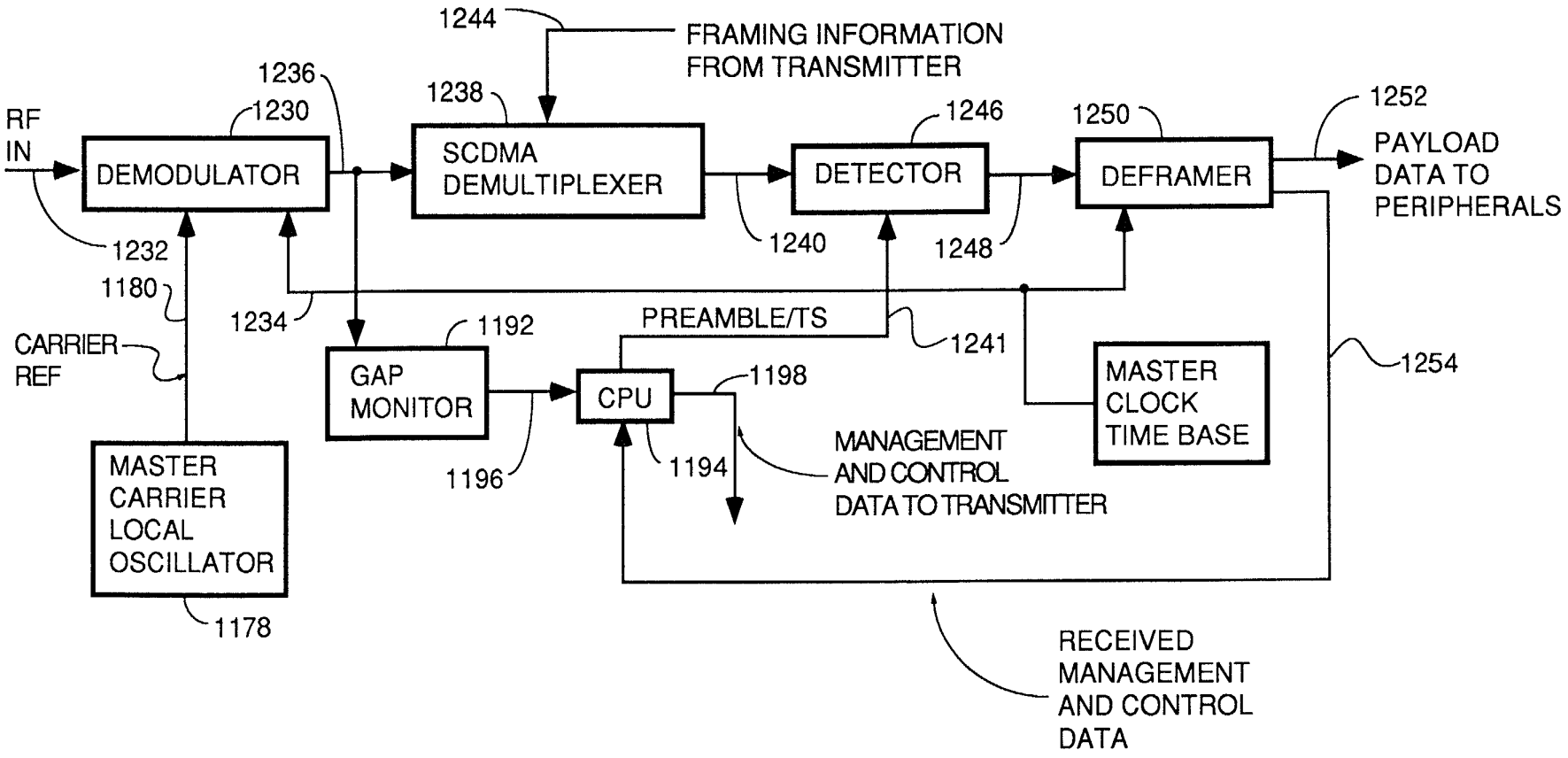
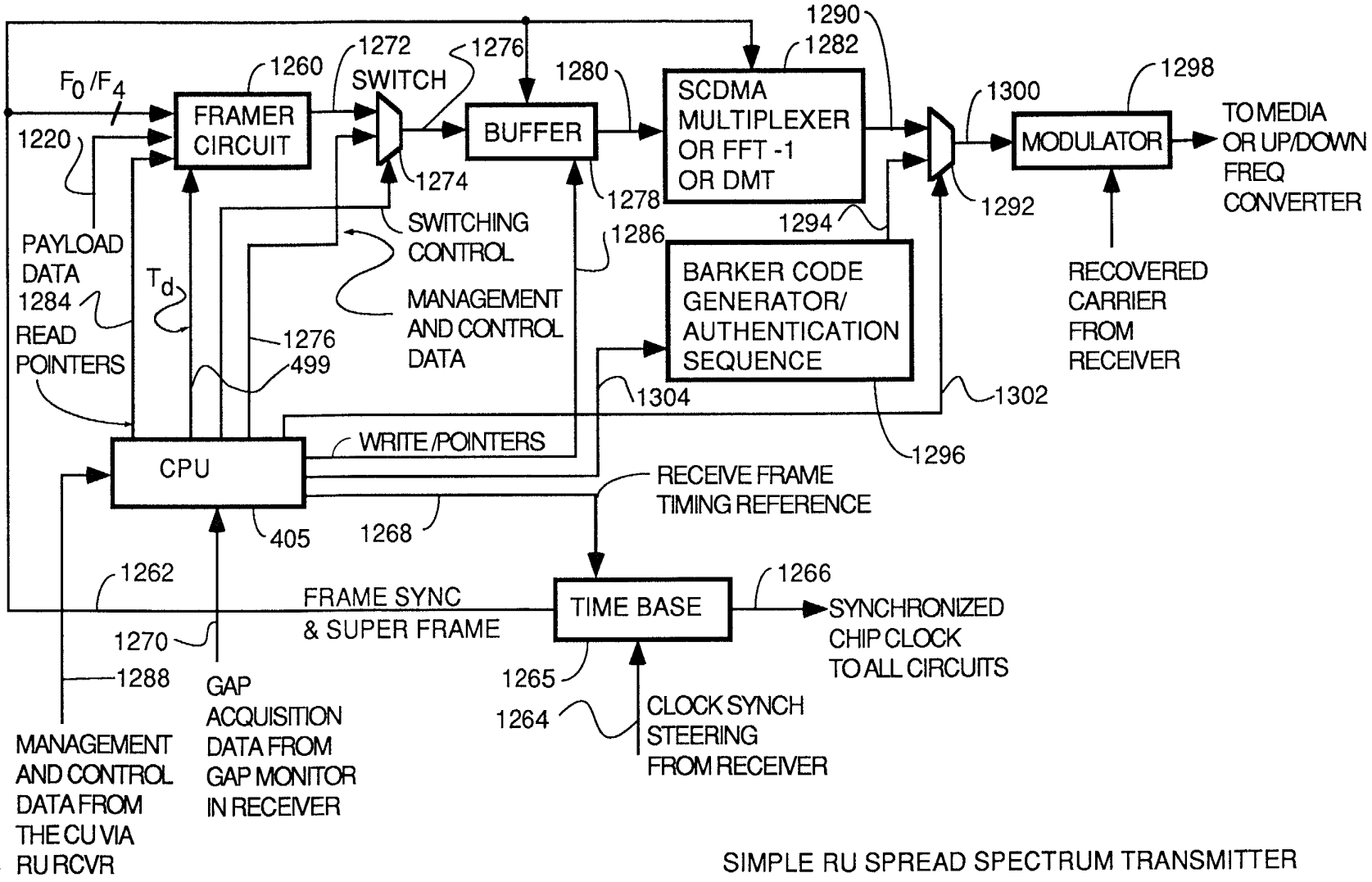


FIG. 54



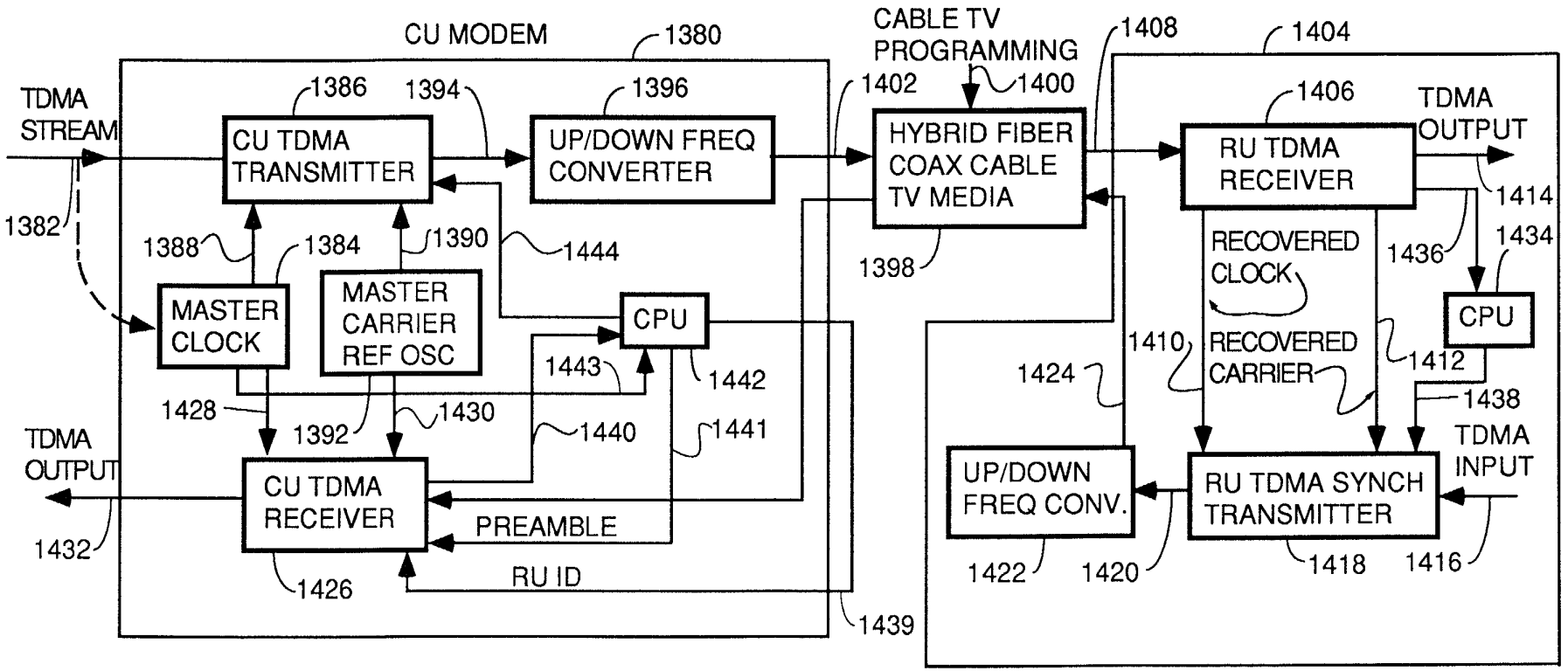
SIMPLE CU SPREAD SPECTRUM RECEIVER

FIG. 55



SIMPLE RU SPREAD SPECTRUM TRANSMITTER

FIG. 56



SYNCHRONOUS TDMA SYSTEM

FIG. 57

OFFSET	1B ASIC		2A ASIC	
(CHIPS)	RGSRH	RGSRL	RGSRH	RGSRL
0	0x0000	0x8000	0x0001	0x0000
1/2	0x0000	0xC000	0x0001	0x8000
1	0x0000	0x4000	0x0000	0x8000
-1	0x0001	0x0000	0x0002	0x0000

FIG. 58

TRAINING ALGORITHM

SE FUNCTION

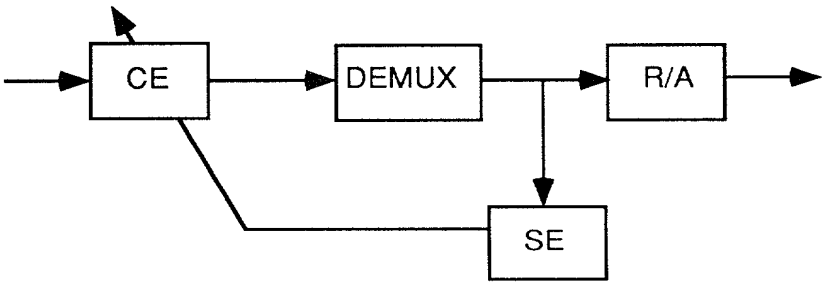
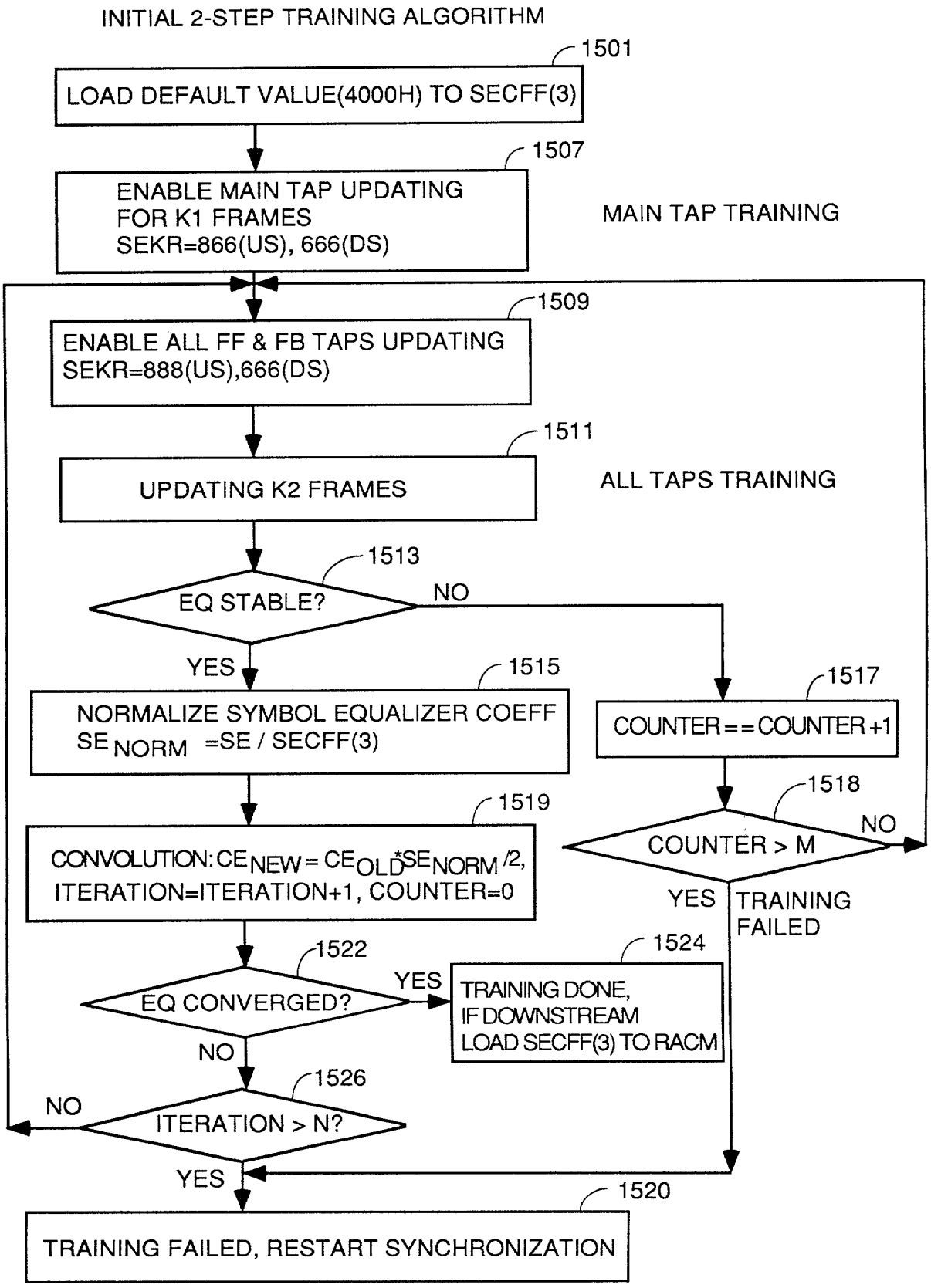


FIG. 59



2-STEP INITIAL EQUALIZATION TRAINING

FIG. 60

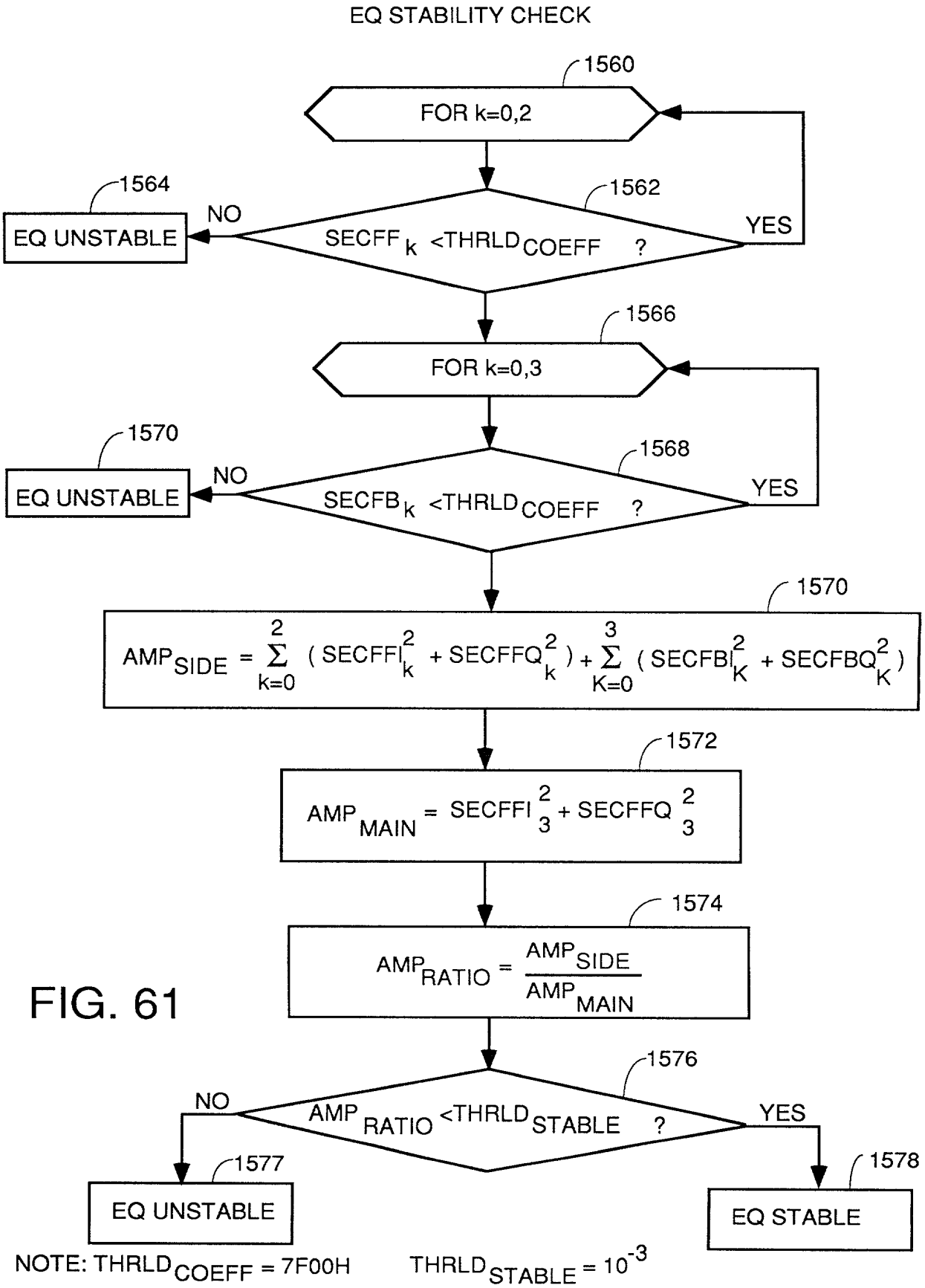
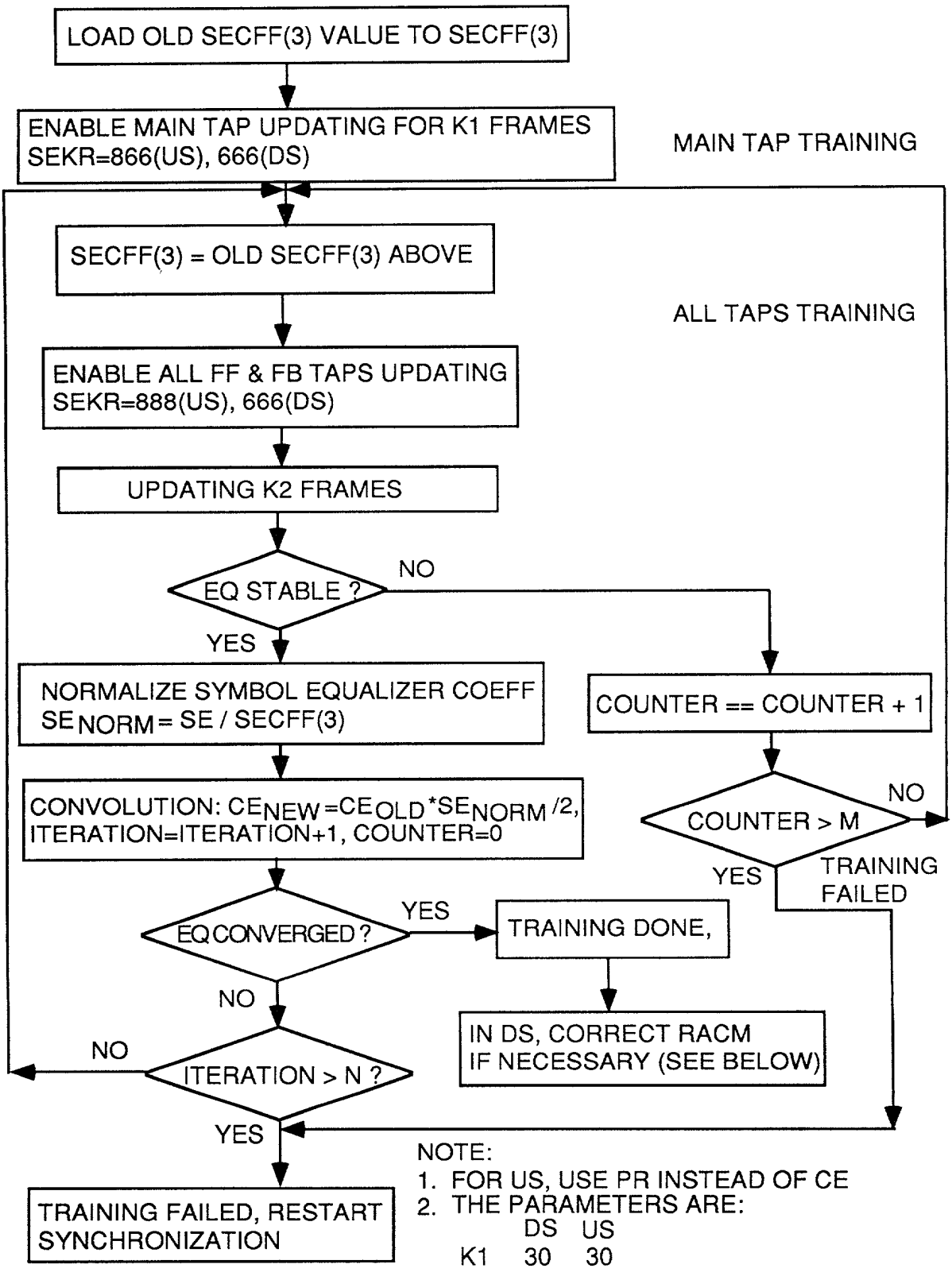

EQ STABILITY CHECK
1560
FOR k=0,2
1562
SECFF k <THRLD COEFF ?
NO
YES
1564
EQ UNSTABLE
1566
FOR k=0,3
1568
SECFB k <THRLD COEFF ?
NO
YES
1570
EQ UNSTABLE
1570
AMP SIDE = Σ k=0 2 (SECFFI k 2 + SECFFQ k 2) + Σ K=0 3 (SECFBI K 2 + SECFBQ K 2)
1572
AMP MAIN = SECFFI 3 2 + SECFFQ 3 2
1574
AMP RATIO = AMP SIDE / AMP MAIN
1576
AMP RATIO <THRLD STABLE ?
NO
YES
1577
EQ UNSTABLE
1578
EQ STABLE
NOTE: THRLD COEFF = 7F00H
THRLD STABLE = 10-3

FIG. 61

PERIODIC 2-STEP TRAINING ALGORITHM



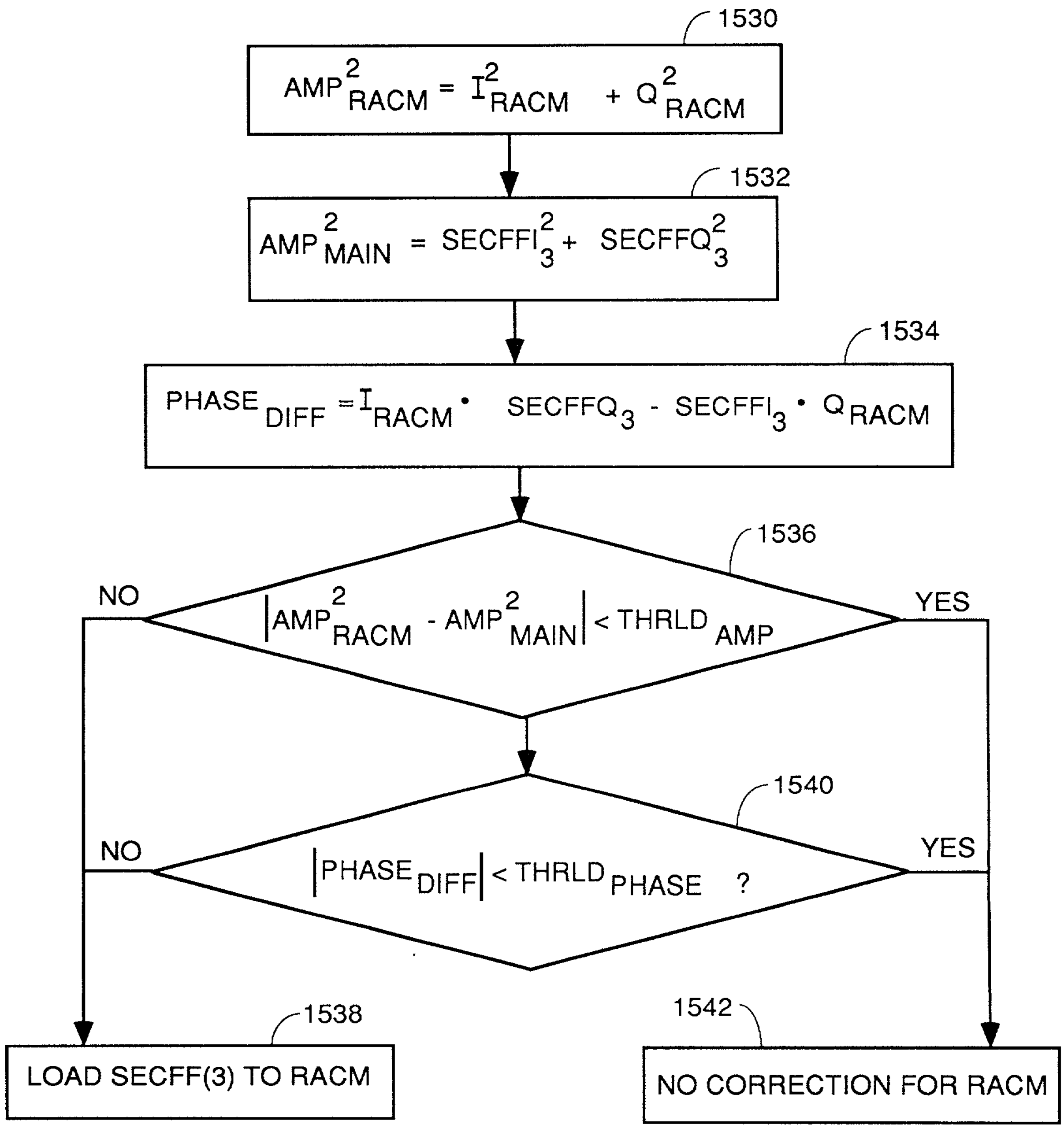
NOTE:

1. FOR US, USE PR INSTEAD OF CE
2. THE PARAMETERS ARE:

	DS	US
K1	30	30
K2	20	30
N	5	3
M	3	3

FIG. 62

RACM CORRECTION



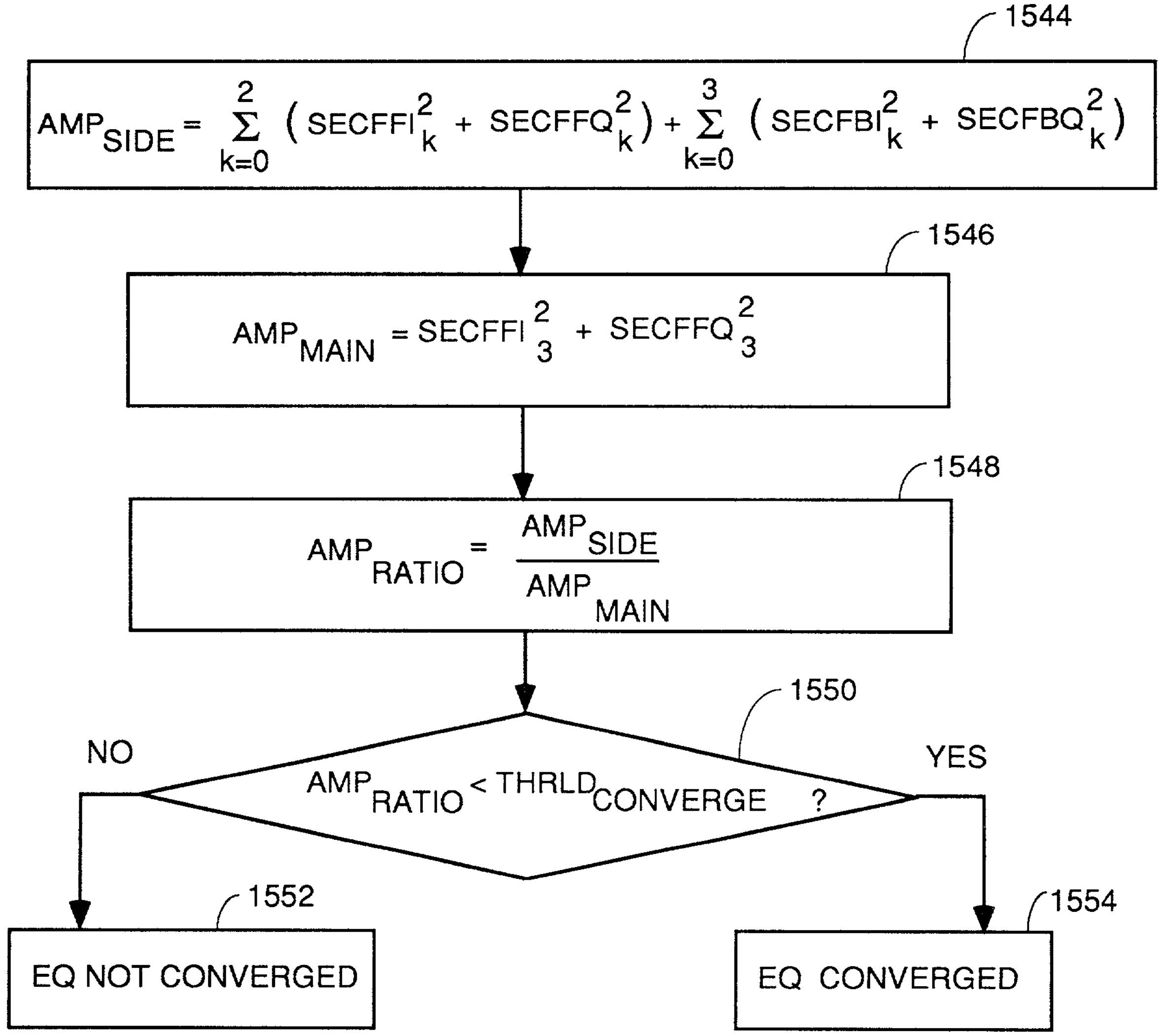
NOTE: $THRLD_{AMP}$ = TBD

$THRLD_{PHASE}$ = TBD

ROTATIONAL AMPLIFIER CORRECTION

FIG. 63

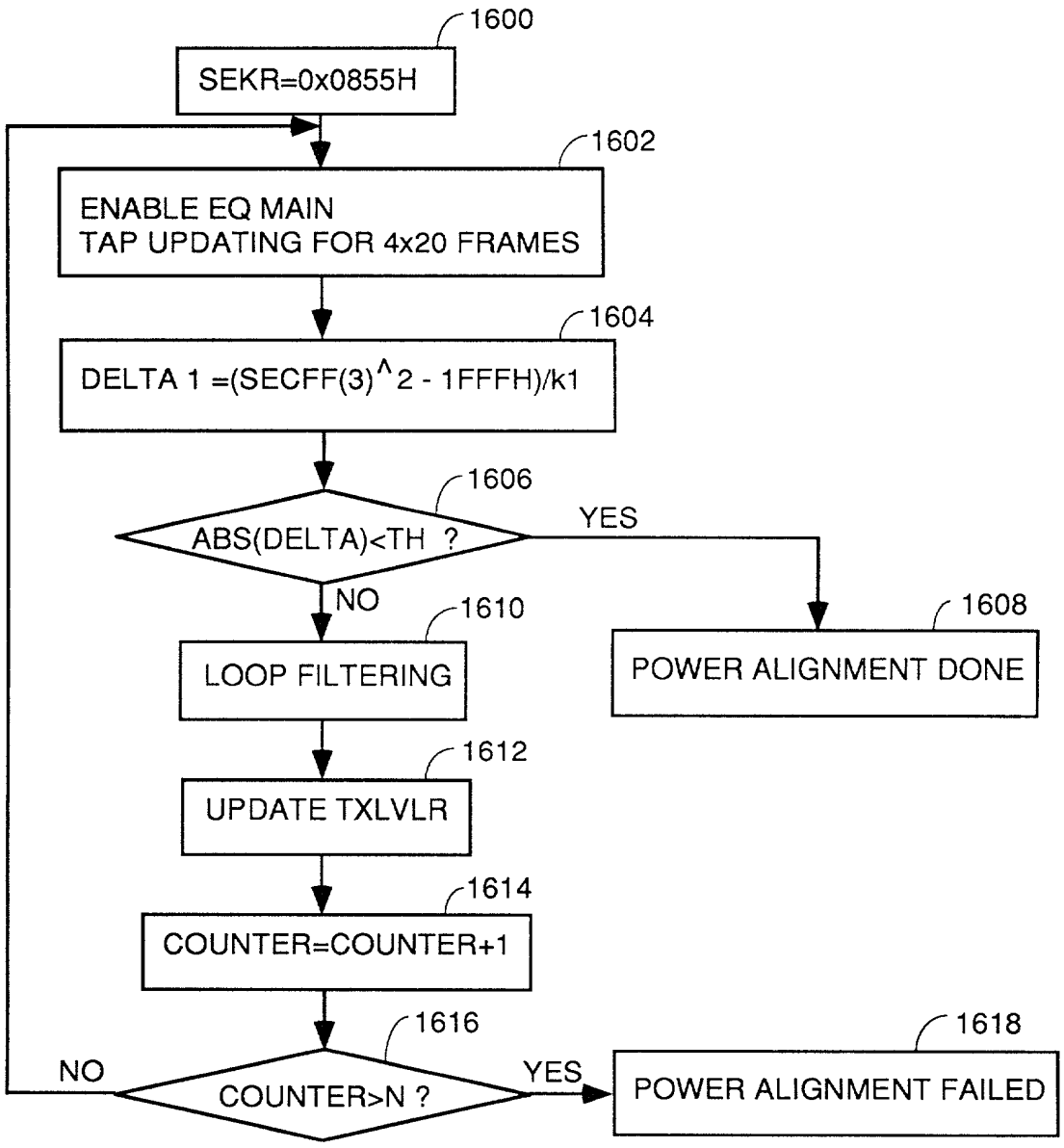
EQ CONVERGENCE CHECK



NOTE: $THRLD_{CONVERGE} = 10^{-5}$

FIG. 64

POWER ALIGNMENT FLOW CHART



NOTE: TH = 600H

N = 12

FIG. 65

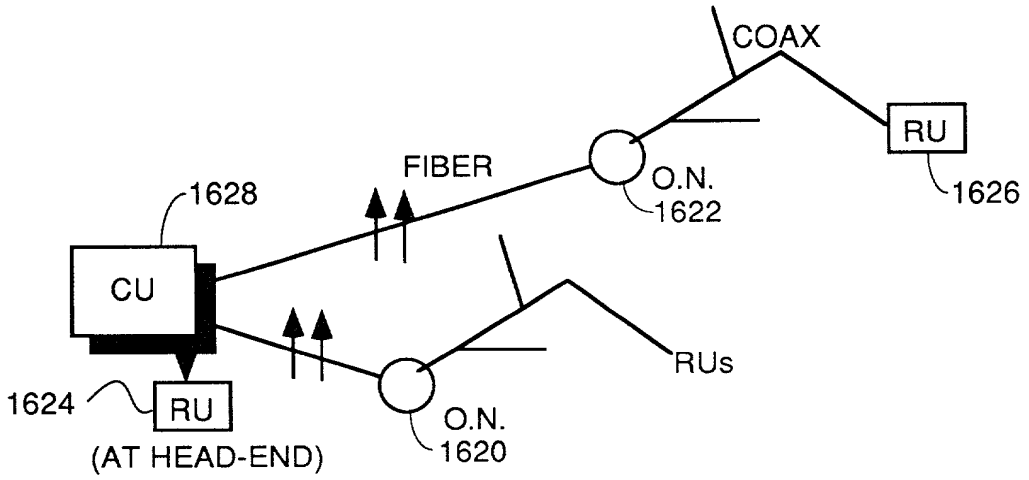
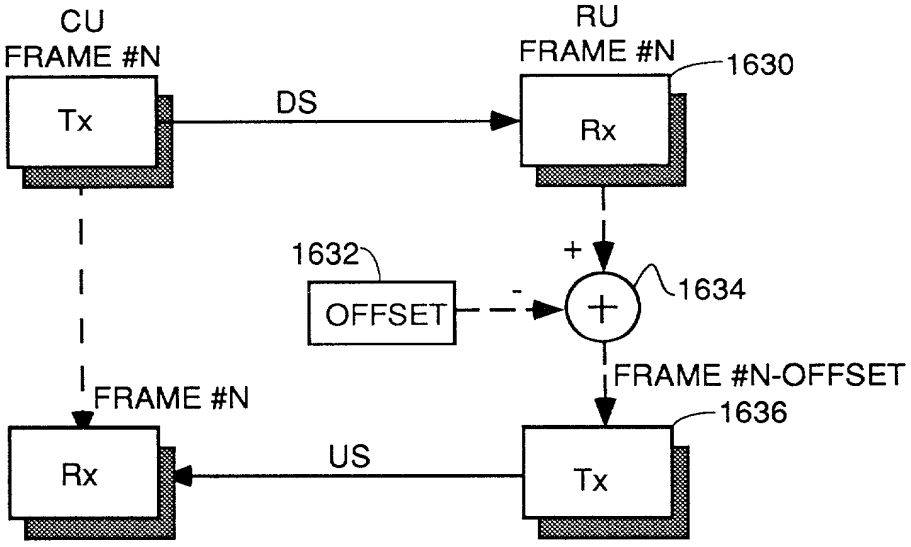


FIG. 66



TOTAL TURN AROUND (TTA) IN FRAMES = OFFSET

FIG. 67

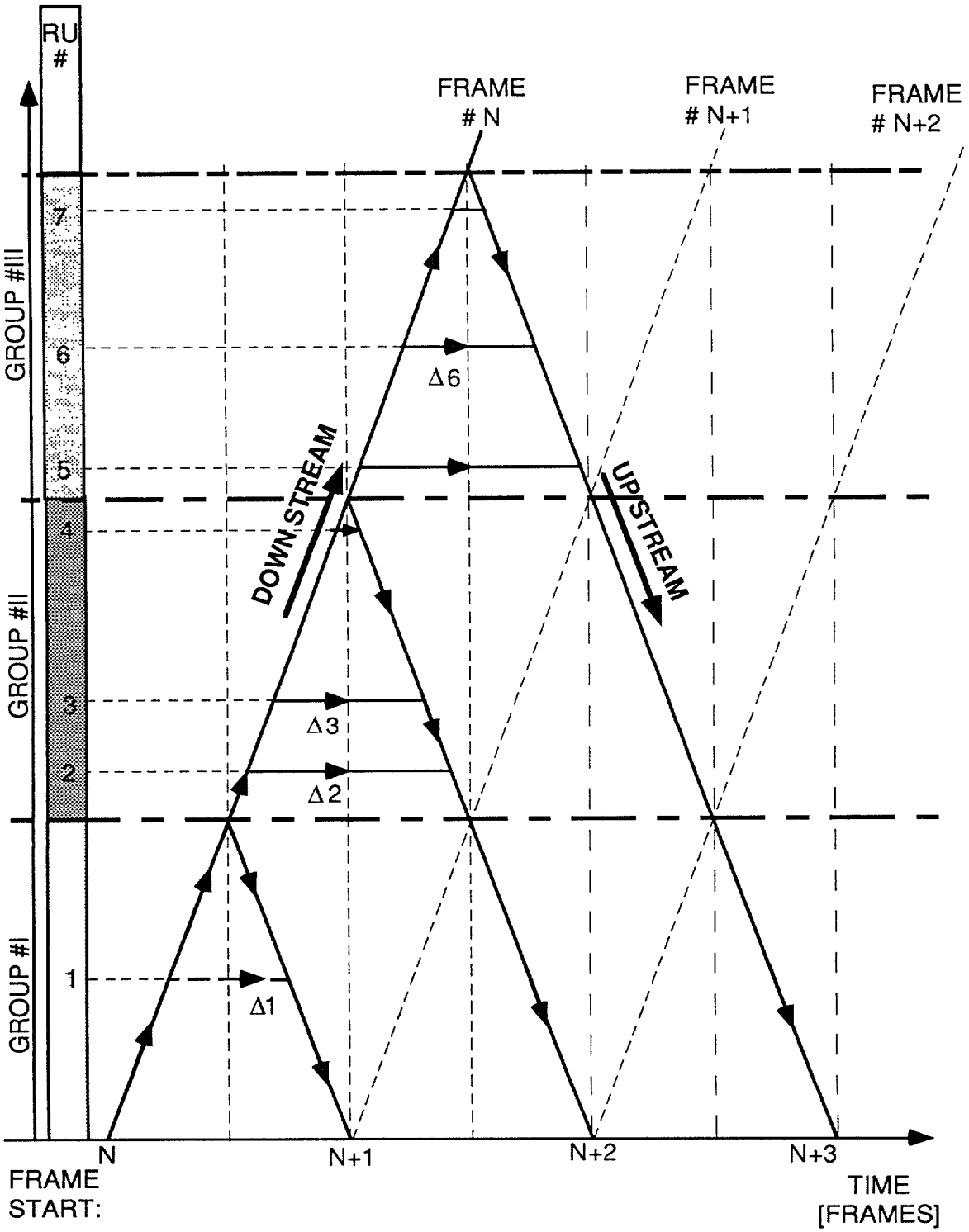
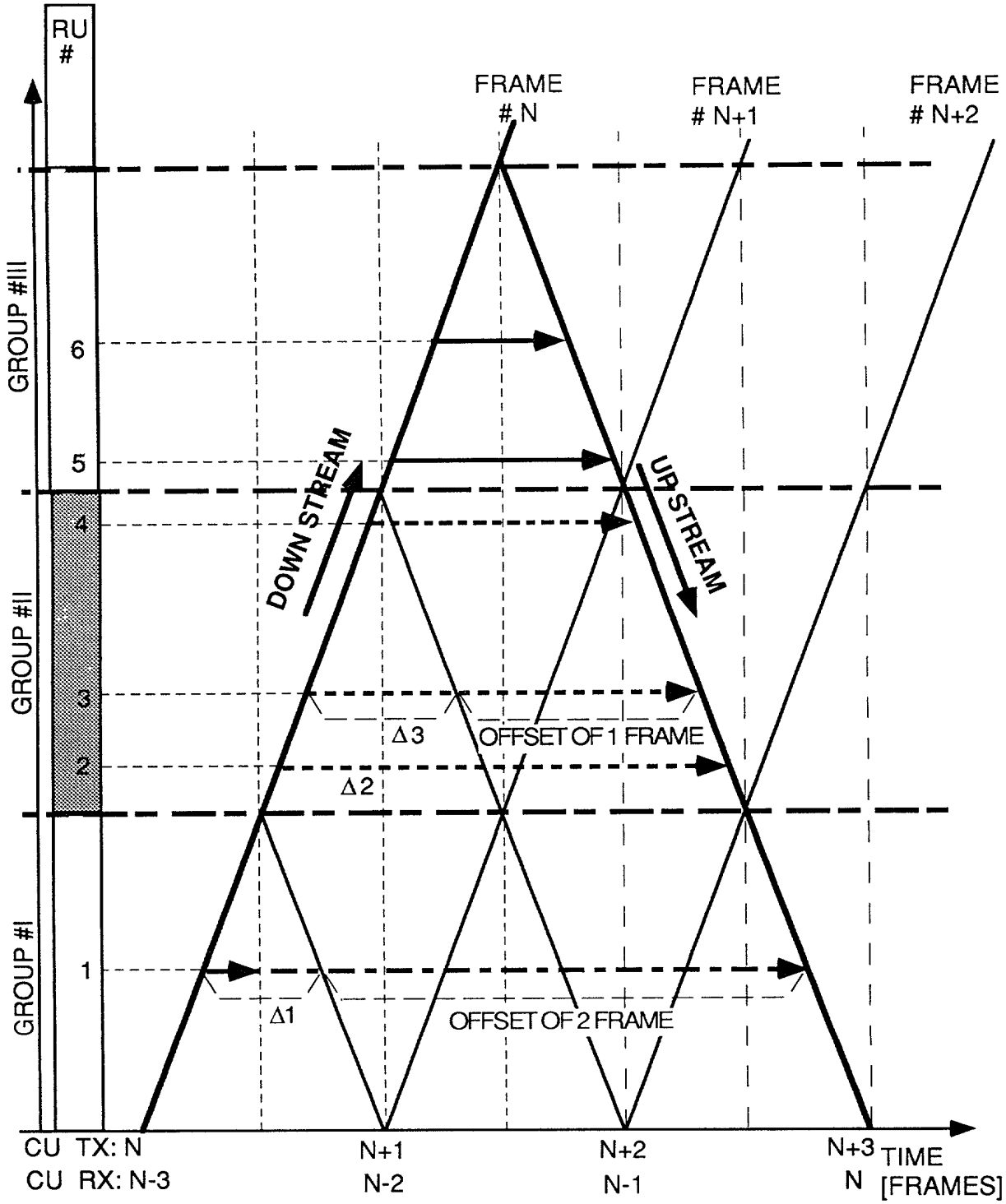

RU #
FRAME # N
FRAME # N+1
FRAME # N+2
GROUP #III
GROUP #II
GROUP #I
7
6
5
4
3
2
1
Δ6
Δ3
Δ2
Δ1
DOWN STREAM
UP STREAM
N
N+1
N+2
N+3
FRAME START:
TIME [FRAMES]

FIG. 68



CONTROL MESSAGE (DOWNSTREAM) AND FUNCTION (UPSTREAM) PROPAGATION IN A 3 FRAMES TTA CHANNEL

FIG. 69

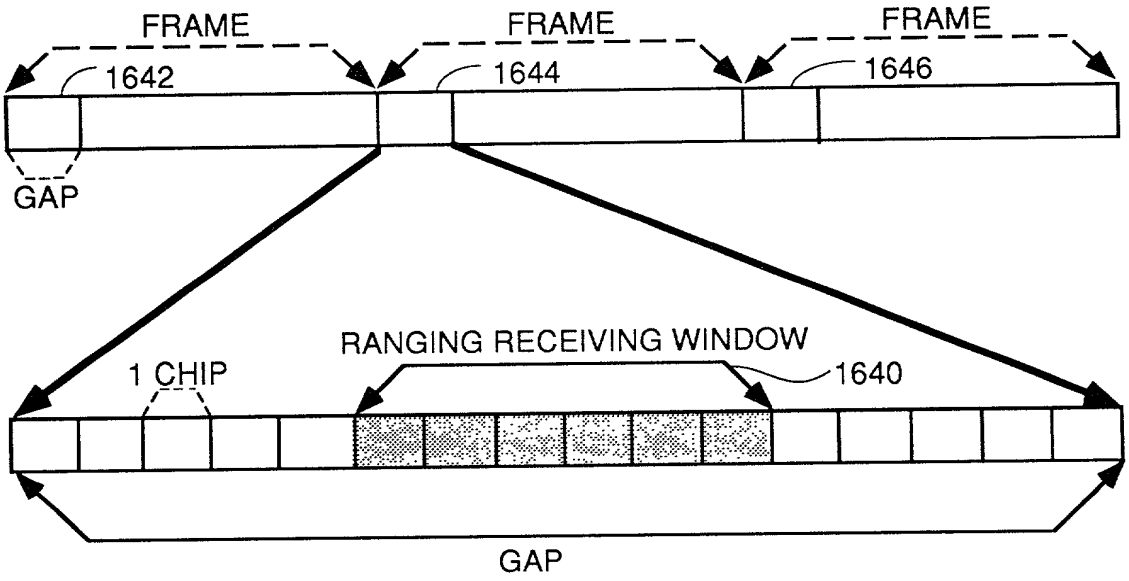
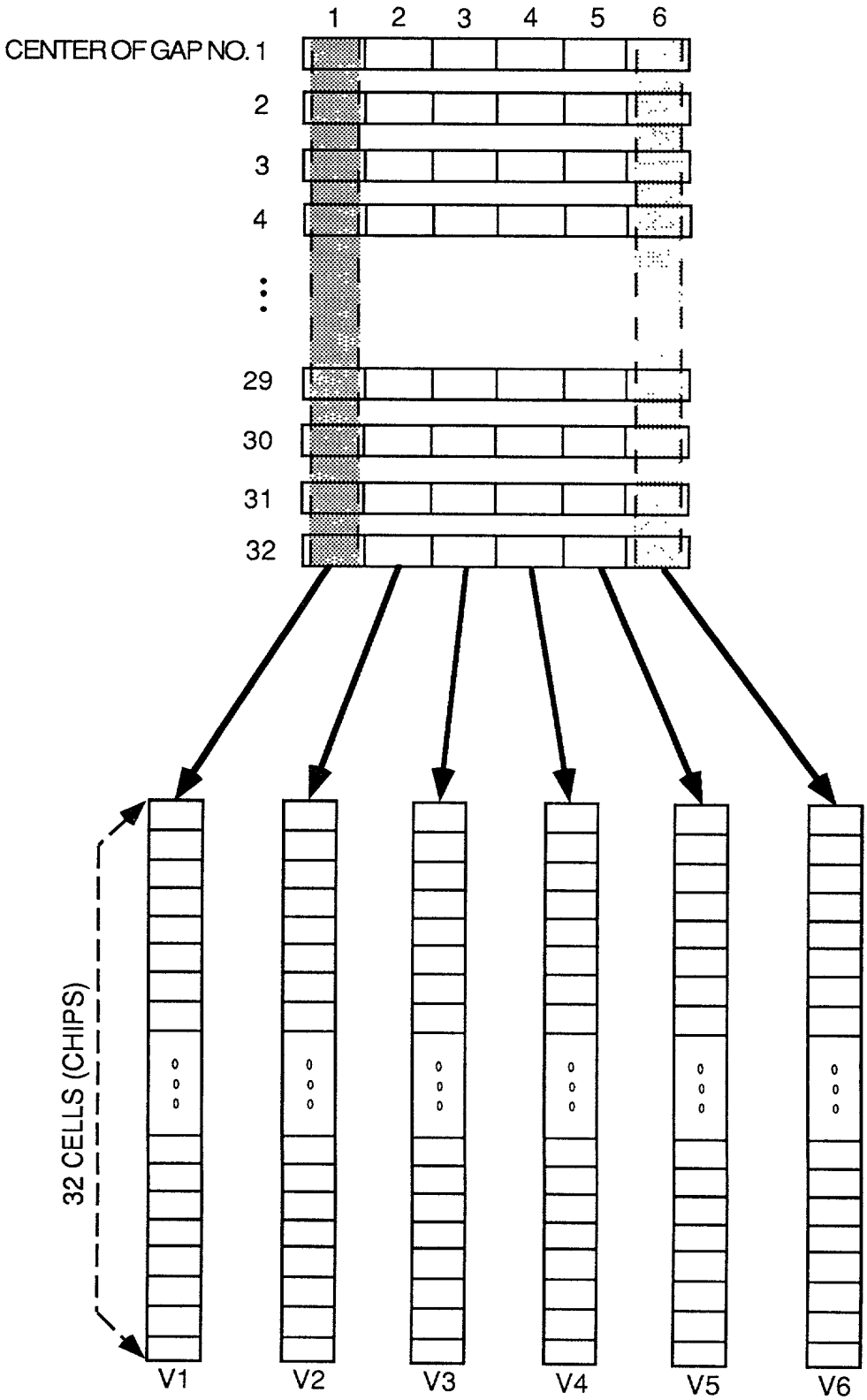

FRAME
FRAME
FRAME
1642
1644
1646
GAP
RANGING RECEIVING WINDOW
1 CHIP
1640
GAP

FIG. 70



OVERALL VIEW OF THE CU SENSING WINDOWS
IN A "BOUNDLESS RANGING" ALGORITHM

FIG. 71

CHIP\FR	1	2	3	4	5	6	7		33
1	0	0	1	0	0	1	1	•••	0
2	1	0	0	1	1	1	1	•••	
3	0	0	0	1	1	1			
4	0	0	0	1	0	0	0	•••	0
5	0	1	0	0	1				
6	0	0	1	1	1				
7	0	0	0	1	1				
8	0	0	0	0	1	0	0	•••	

FIG. 72